QRP Quarterly

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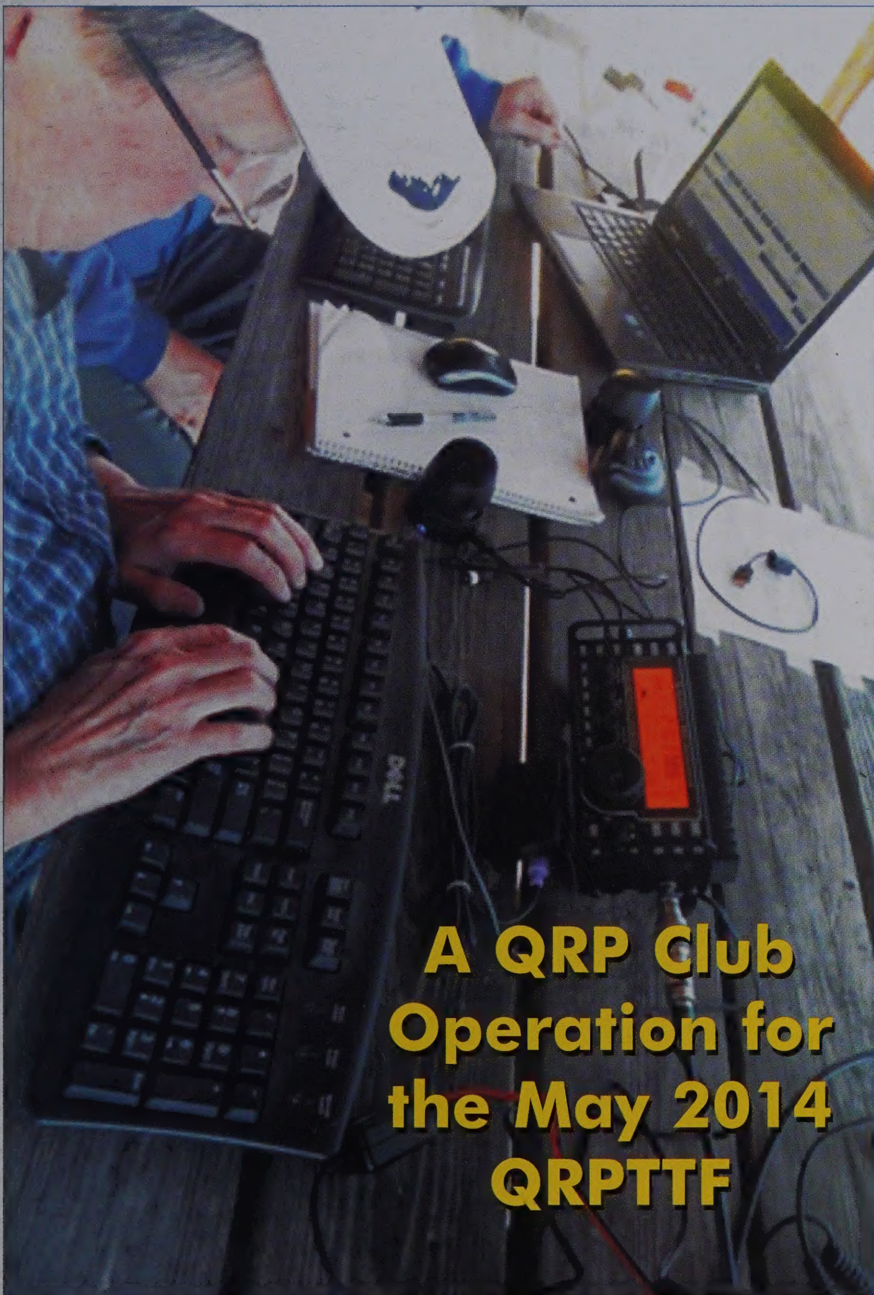
Summer 2014

Journal of the QRP Amateur Radio Club International



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QRP ARCI℠ is a non-profit organization dedicated to increasing worldwide enjoyment of radio operation, experimentation and the formation and promotion of QRP clubs throughout the world.

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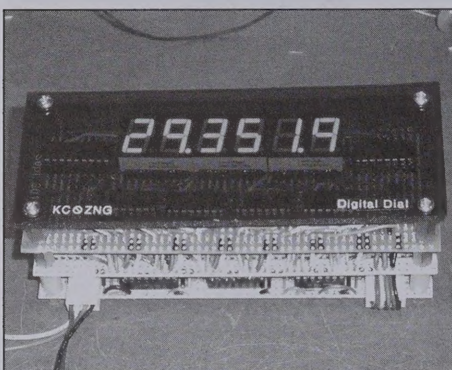

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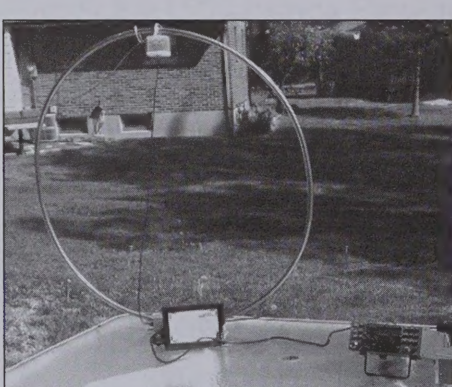

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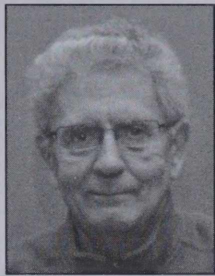


I hope everyone is enjoying the summer weather and operating. After the winter most of us had to get through, the change of seasons is very welcome. I am at a new residence that, fortunately, is not in a subdivision, so I will be installing my Mosely 10-15-20 M rotatable dipole. This used to be my antenna but in a subdivision with restrictions, it got put in the garage and out of use.

As some of you know, my divorce was final last June, and my realtor told me December and January were good months for selling the house. I did not mind but it meant I had to take my dog for 2-3 hour drives each time the house got looked at. And a couple folks came back for a second and third looks! Finally, the house got sold and I got myself a new place. The problem was that the move date was earlier than I was expecting, right when the last issue was in the works. So, I have to give credit to the Associate Editors, the Board of Directors and Gary Breed, K9AY, for pitching in to get that issue out to you. I do not know exactly what each person did but I do thank each and every one of them. [That's what *team* members do for one another, Tim!]

For those of us who made it to FDIM this year, I hope you had as wonderful a time at the meeting as I did. The hotel likes us and our meeting and try to do all they can for us. I was glad to get a writeup done about the FDIM 2014 activities.

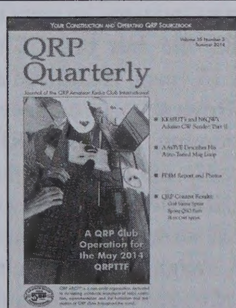
I will not get into my computer problems I have had for the last couple months, but much of my email went to "trash". There was at least one article sent to me that I cannot find anywhere. If that was you, I really apologize and ask that you send it to me again. I just had both of my computers really gone over and upgraded. The guy who did it for me designed his own 8-core computer. I have a new Internet and e-mail service provider.

As you might suspect, living in the earlier subdivision with restrictions really cut into my operating and building time. I had gotten several kits and never even started them! This is going to be changing. First, I am going to download all the building directions I can find for these kits and have a go at it. I also have to figure out where I am going to do all this in my smaller house. However, I started by building a new radio work table.

If you have a project you have completed, why not write it up and send it in for publication? That is how articles get in *QQ*. If you are not sure of your writing expertise, we will certainly help you.

That is it for now. Enjoy QRPing!

—72/73 de WB9NLZ



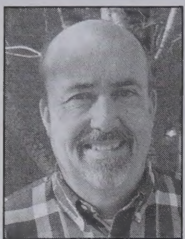
On the Cover

This past May 3, the Columbus, OH-based CRES-ARC QRP Special Interest Group made a trip to Great Seal Park near Chillicothe, OH for QRPTTF. With a modest hilltop site, the park is a fine QTH for portable operation. The cover photo shows Fred, WA8PGE making QSOs on 15M using the KX3 transceiver with computer CW and logging. The story is included in this issue's QRP Clubhouse column, which begins on page 24.

From the President

Ken Evans—W4DU

president@qrparci.org



FDIM 2014

FDIM 2014 is now history. A great deal of effort by an all volunteer team made it come together. Numerous volunteers worked to insure all went well. Many of you have asked me about numbers as it seemed more crowded than usual this year. Surprisingly, this year was the highest attendance numbers in the history of FDIM. The two events that require registration (thus we can accurately report attendance numbers) are the Seminar and the Awards Banquet. This year we had 290 people at the Seminar and 228 at the Awards Banquet. Both of these numbers are "high water marks". The ballroom on both Vendor Night (Thursday) and Club Night (Friday) was packed. The web casting of the Seminar was well received with over 400 watching some or all of the talks from all continents. We hope you enjoyed this inclusionary effort and are planning to continue to webcast when ever possible. The seminar talks will eventually be available on YouTube. Finally, the entire block of hotel rooms set aside for QRP ARCI was sold out, indicating a preference to stay at the "FDIM Central". We will endeavor to have more rooms available in the future.

QRP Hall of Fame

For more than 25 years, the club has honored those who have made a significant contribution to the world of QRP. The recognition is induction into the QRP ARCI Hall of Fame. Inductees are honored at the FDIM Awards Banquet with a plaque presented to them by QRP ARCI. Nominations may be submitted by anyone, whether a member of the QRP ARCI or not. Similarly, membership in QRP ARCI is not required for someone to receive the honor, since this is an award to recognize those who have made great ongoing contributions to the QRP community, not just to the QRP ARCI. The voting body consists of the QRP ARCI Board of Directors, President, Vice-President and last eight members inducted into the Hall of Fame. Of the nominations received this year, three people received the two thirds majority of the voting body required to be inducted into the hall of Fame. They are:

David Cripe, NMØS
Ed Hare, W1RFI
Zack Lau, W1VT

Dave Cripe, NMØS

Dave has given copiously of his free time to further the QRP cause, while being very busy with family and work load as an EE design engineer at Rockwell Collins, Cedar Rapids, IA. His caring and sharing attitude, as well as his numerous accomplishments marks him as deserving member of the HOF. Below are some of his contributions to the QRP cause. A prolific design engineer, he has designed and developed 6 kits for the Four State QRP Group. His designs feature diversity, innovation and low parts count, while maintaining excellent performance. Those kits are: the Cyclone Transceiver, 4S-Link Digital Interface, Hi-Per-Mite Audio CW Filter, QRPometer Power and SWR meter, NS-40 Class E transmitter and Ham Can Minimalist Transceiver. Dave is a perennial presenter at OzarkCon, and also provides strong support for the build session, both with his designs and presence. Additionally he serves on the Four State Board of Directors. To say that he is a mainstay of the Four State QRP Group would be an understatement. He has also spoken at FDIM, and has entered the homebrew contest for many years.

Ed Hare, W1RFI

For an enthusiastic lifetime of service to QRP ARCI, ARRL, the QRP community and one of BPL's strongest pallbearers. Ed was first licensed in 1963. After 16 years in the electronics industry, he went to ARRL HQ in 1986. He has been with ARRL HQ for over 13 years. He started as ARRL's "Product Review" test engineer, moved on to becoming ARRL's "RFI guru" (notice his call!) and he now holds the position of Laboratory Supervisor. Over the years he has written quite a number of RFI articles, ranging from articles for *QST* and the *ARRL Handbook* to articles that have appeared in professional trade journals. He is also one of the editors and authors of the *ARRL RFI Book* and the author of the ARRL's book on RF exposure, *RF Exposure and You*. Ed has served on the QRP ARCI Board of Directors for 7 years and has enthusiastically supported QRP and QRP designs. He has spoken at FDIM several times and served as a judge in many of the QRP homebrew contests.

Zack Lau, W1VT

Zack's technical prowess ranges from DC through the microwave region and with technology as diverse as entire radios, antennas, transverters, filters, and integrated stations. W1VT is the perfect embodiment of W7ZOI's admonition in his book EMRFD, "Build what you operate and operate what you build." Zack operates the rigs he builds and is famous in the VHF/microwave world for his homebrew portable QRP station, which includes homebrew QRP rigs for all bands from 222 MHz to 24 GHz. His home station is largely homebrew, and is consistently a winner in the QRP Portable categories. Zack was one of the first QRP designers to recognize the value of the now ubiquitous NE602 as a QRP building block with his article in October 1989 *QST*, "The QRP Three-Bander". This transceiver was built by 100s of QRPers and was a mainstay of the QRP homebrew crowd for several years until the advent of the simple single-band superheterodyne transceivers, also based on the NE602. In a tribute as to how influential the rig is, there are still questions by prospective builders posted on QRP-L about building this rig and FAR circuits still carries circuit boards for it.

The Future

Next year will mark the twentieth anniversary of FDIM. We are looking for ways to make this a special event. If you have any ideas, please submit them to fdim20@qrparci.org. We are open to any and all suggestions. So put on the thinking caps and let us hear from you. Let's make this twentieth anniversary extra special

—72, Ken Evans, W4DU
President, QRP ARCI

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of Idea Exchange:

Further Adventures with the Companion Multiband Antenna

Joe Everhart, N2CX, continues the endless string of Technical Quickies he promised me years ago with #90—

In Quickie 89 (Ref 1), I discussed my ideas for a QRP multiband antenna (MBA) to be a companion to my KX3 including a switching and matching unit. Unfortunately, life got in the way and construction progress has been delayed. However, I have done some measurements to assess the practicality of my system so in this Quickie I'll let you look over my shoulder to see what's going on.

[All references and notes appear at the end of the article that mentions them. —WA8MCQ]

The antenna itself is rather simple, a wire about a quarter wavelength long on 80 meters erected in a lopsided inverted U shape, shown in Figure 1. Last time, a 66 foot wire was mentioned although an approximately 67 foot wire was used for the measurements described herein. The exact length will be chosen during final construction some time later this year. It also has a ground radial system of 10 buried wires of lengths ranging from 30 to 50 feet.

The basic idea is that the quarter wave wire on 80 meters also has resonances on harmonic frequencies. At odd multiples of the fundamental (3, 5, 7, etc.) the feedpoint impedance will be low and potentially close to 50 ohms. At even multiples the impedances will be several thousand ohms but, ideally, with low reactance.

Of course anyone who has ever tried this realizes that resonances at multiples of the base frequency are close but not exactly at precise harmonics. This is likely due to the so-called "end-effect" which lowers the fundamental resonance frequency but not harmonics. I would have loved to have verified this with the EZNEC antenna modeling software but time ran short to do this and switching to a new computer meant that I needed to get a fresh disc to reload the software.

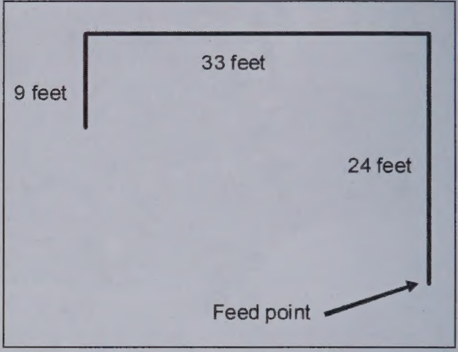


Figure 1—Lopsided inverted U multiband antenna, with 2 vertical legs and a horizontal top.

Using the antenna on both odd and even harmonics and feeding it with 50 ohm coaxial cable meant use of some sort of matching network. As described in the original article I intend to use direct feed on 80 and 30 meters where the feedpoint impedance should be close to 50 ohms. However, on 40/20/15/10 meters the very high impedance needs to be transformed down from the several thousand ohm range. For this, a PAR/LNR EF-10/20/40 matching device will do the trick (Ref 2). So, as previously described, my design has

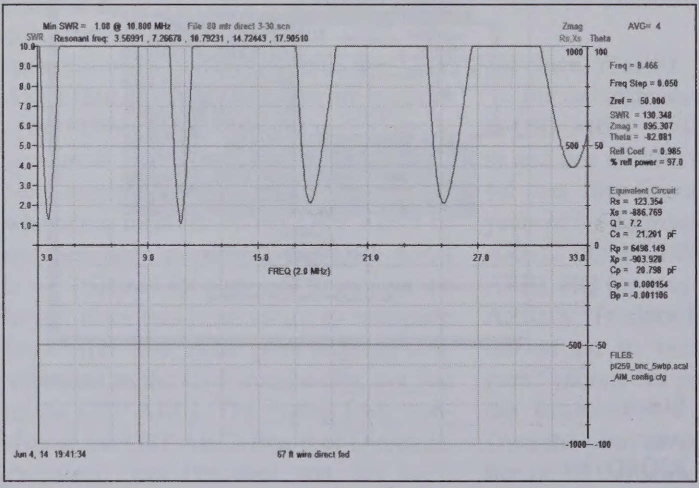


Figure 2—SWR vs. frequency with analyzer connected directly to the antenna feed point.

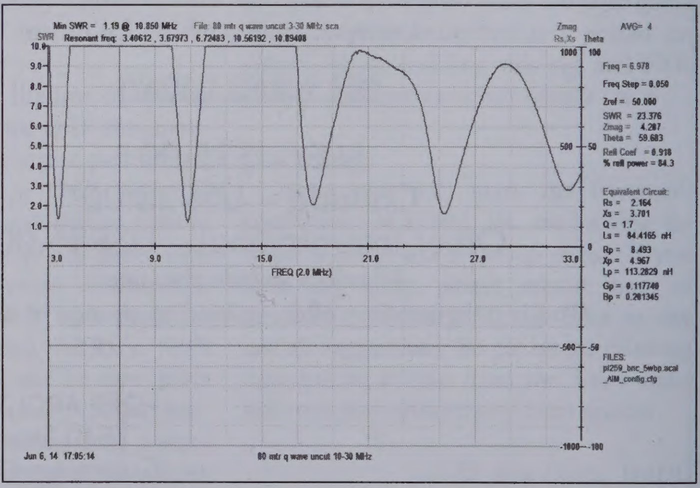


Figure 3—SWR vs. frequency with antenna fed through 30 feet of RG-58 coax.

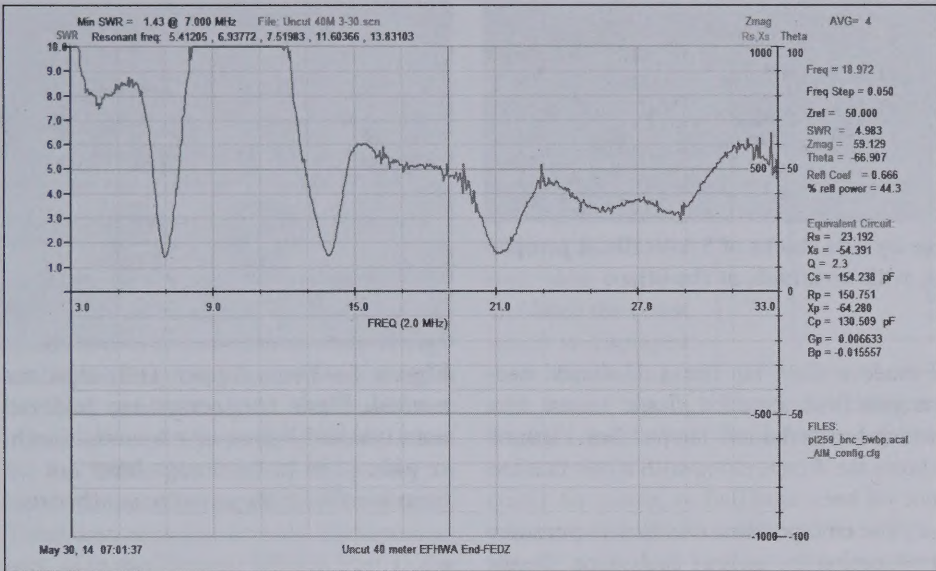


Figure 4—SWR vs frequency with End-Fedz matcher and 30 feet of RG-58.

to include the ability to switch this device in and out.

With a 67 foot wire in place I used my trusty AIM4170 Antenna Analyzer (Ref 3) to perform a series of measurements. This device is invaluable in performing accurate and precise measurements—impedance, SWR, etc.—on antennas in the 100 kHz to 170 MHz range. It has an advantage over many other devices in that it will operate effectively even in the presence of strong out-of-band energy on the antenna due to nearby AM broadcast stations. Simpler antenna analyzers are problematic at my QTH since I have several such broadcast stations within a few miles of where I live.

Using this sophisticated instrument, however, requires a fundamental understanding of antenna principles and what all of the numbers mean! It takes quite a while and lots of technical reading to appreciate all of the device's measurement capabilities.

Figure 2 is a sweep of SWR with the analyzer connected directly at the base of the 67 foot ""U" with the radial system in place. Much more data was taken but this clearly shows the low SWR readings near 3.5 MHz, at about 10.5 MHz and, not surprisingly, near 18 MHz. This is quite promising for direct feed of the antenna with coax cable. Even though the SWR values are above 2:1 in several cases, they are not high enough to cause large losses in coax feedline on the desired ham bands.

Figure 3 shows the same sweep at the shack end of 30 feet of RG-58 feedline. While not optimum, the antenna will probably be quite usable on all 3 bands and within the matching range of the KX3 internal tuner.

Now the question remained of how well the PAR End-Fedz matcher would handle the even harmonic frequencies, particularly on the 7, 14, 21 and 28 MHz bands. With the original electrically shorted 10/20/40 wire the matcher gives an SWR of under 2:1 on 7, 14 and 28 MHz. Plus it has worked quite well for both fixed and portable use. The result with the "full-length" 67 foot wire looks quite promising as can be seen in Figure 4. Acceptable SWR is achieved on 7 and 14 MHz, plus it looks like 21 MHz is in range as well. 28 MHz is somewhat higher and on-the-air testing is needed to see how effective the antenna is.

The measurements described in this Quickie support the original premise that a simple 67 foot wire can be matched to a 50 ohm coax cable with the methods outlined. Quite surely there is no guarantee that low SWR equates to effective radiation. In the absence of a professional antenna measurement range, the next step in evaluating the antenna is to do some on-air testing using the Reverse Beacon Network and (horror of horrors) actual live contacts. Results of antenna use will be detailed in a later Quickie.

References

1. Joe's Quickie No. 89, "Companion MultiBand Antenna," Idea Exchange column, *QRP Quarterly*, Winter 2014.

2. LNR EF-10/20/40 antenna: http://www.lnrprecision.com/endfedz-specs/

3. AIM4170 Antenna Analyzer: http://www.w5big.com/purchase4170c.htm

—de N2CX

Drawback of Making PCBs with Blue Material

Making PCBs at home is a recurring topic on the qrp-tech forum on yahoo.com. Most of us probably use the regular light green FR4 copper clad material but it is also available in other colors. This cautionary tale was posted by Gene Dorcas, W5DOR.

I thought it would be cool to use blue PCB material instead of that ugly green. Well, as it turns out it creates a problem while you're etching the board. The etch resist is black and the material is dark blue so while you're etching it's difficult to tell the difference. That is, when all the etching is complete the board will appear to be completely black. It's better to use a light colored PCB material so you can see the progress while it's in the etchant.

If you really want to use the blue material you can use a high powered LED light up close to monitor your etching progress.

—de W5DOR

Heavy Duty AA Cell Holder

From Les Austin, GØNMD, a heavy-duty battery holder for portable use made with items from the hardware store—

There seems to have been recent interest in various battery configurations for QRP and portable use, including the use of various lithium batteries (LiPo and LiFePo). I thought I would add my two pence worth to the debate.

Several years ago I tried to lighten my load by replacing a SLAB (sealed lead acid battery) with something else. LiPo was not an option at the time, so I plumbed for the (then) NiCad AA cells.

However, I was quickly disenchanted by the standard, spring-loaded battery holders, with springs that flatten out, pressed-together connections that add resistance to the supply chain plus the danger of internal corrosion, and the suspect "press-stud" connectors.

I decided to make my own battery packs for AA cells, following the general rule: Look at what the do-it-yourself stores

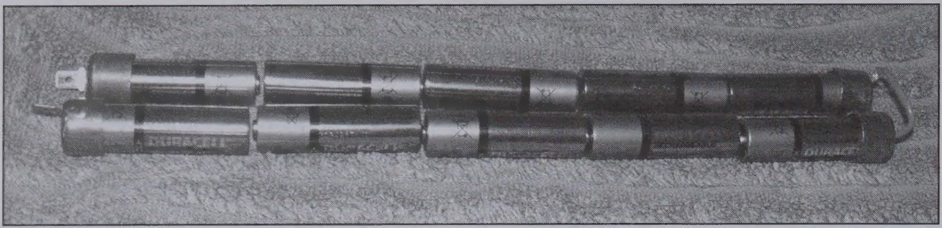


Figure 5—The holder accommodates two side by side stacks of 5 AA cells. A jumper wire is used at one end to put them in series, with terminals at the other.

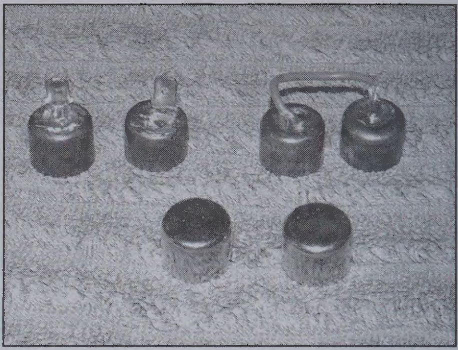


Figure 6—Four copper end caps are needed. Blade connectors are soldered onto two and a jumper wire onto another pair. (The lower 2 caps have not yet been modified; they are for another set.)

have to offer.

I got PVC overflow pipe which would make a holder for AA cells. And I found that small copper plumbing "stop-ends" (15 mm) allowed an AA cell inside, and also would slide inside the pipe. The pipe I used is white PVC, 20 mm (0.79 inch) OD, 17.3 mm (0.68 inch) inside diameter.

[*WA8MCQ comments:* I did a bit of research in the plumbing section of a local Lowes home improvement store to see what size items we would buy over here. Use 1/2" copper end caps and 3/4" PVC schedule 40 tubing. I took along an old AA cell to be sure everything fits together OK. Note that those dimensions refer to the pipe size and are not the actual outer diameters.]

I put ten AA cells end to end on the bench and thought for a moment. It was too long, but two rows of five each was reasonable (Figure 5). I would need two lengths of pipe and four end caps, plus some way of holding them together.

I wanted my battery packs to have the same connectors as my old SLAB to allow one connecting lead to do duty with both battery types. That meant a trip to a car-parts shop to get some blade connectors (called "Lucar connectors" over here).

I found that the end caps were domed (convex), which caused a problem with contacts between the inside and the negative end of the cells, so put them on the workshop bench and tapped all four of them with a small hammer and a piece of metal rod. They are thin copper alloy and not strong so they only need a light tap, just enough to make them concave on the outer end and provide a raised contact point on the inside.

This concave end is just right to receive a puddle of solder; I used soft multi-core solder after cleaning the ends with emery cloth. I put blade connectors into the puddles on two caps, bent at right angles to stand up from the caps. With the other two I made a short but heavy U-shaped connection from stranded plastic coated wire which I soldered into the puddles. Figure 6 shows the 4 caps along with a pair that has not yet been modified.

The next problem was how to put some pressure on the ends of each stack of cells to maintain contact between them. After thinking for a while and sleeping on it (laying awake, turning it over in my mind) I decided on using elastic cord, also sold in hardware shops.

The overflow pipe was now cut to length. I wanted five cells in each but wanted the contacts at each end to be inside, protected from damage and shorts when I carry them in my rucksack. I cut the tubes slightly over-length which allowed the caps to slide up inside them, putting the connections out of harms way. Then I cut slots which hold the elastic cords in place as well as allowing them to put pressure on the stacks of cells. I marked the tubes to show cell orientation, first with permanent markers (red and black) then, in a later effort, by using heat-shrink tubing of the appropriate colours. A larger piece of heat-shrink at each end holds the tubes together. Figure 7 shows an assembled unit in the center, along with another awaiting assembly

This arrangement has been my standard battery for all my portable operations on the beach, and on various hilltops with Summits on the Air (SOTA). It's acceptable as carry-on luggage with European airlines, which SLABs are not. It is also easily adaptable; for instance, it would easily cope with the type of lithium ion cells used by Howard, K4LXY, in his item in the Winter 2014 issue, and can take the connectors of your choice, say PowerPoles or similar, on a wire soldered to the top end-caps. The total weight of 10 AA NiMH cells in one of these packs is about 14 ounces. That is less than half the weight of my old 2.1 Ah SLAB, and gives me 2.4 Ah in the bargain. That's just right with my Elecraft KX3 or my K1 for several hours use on a hilltop.

—de GØNMD

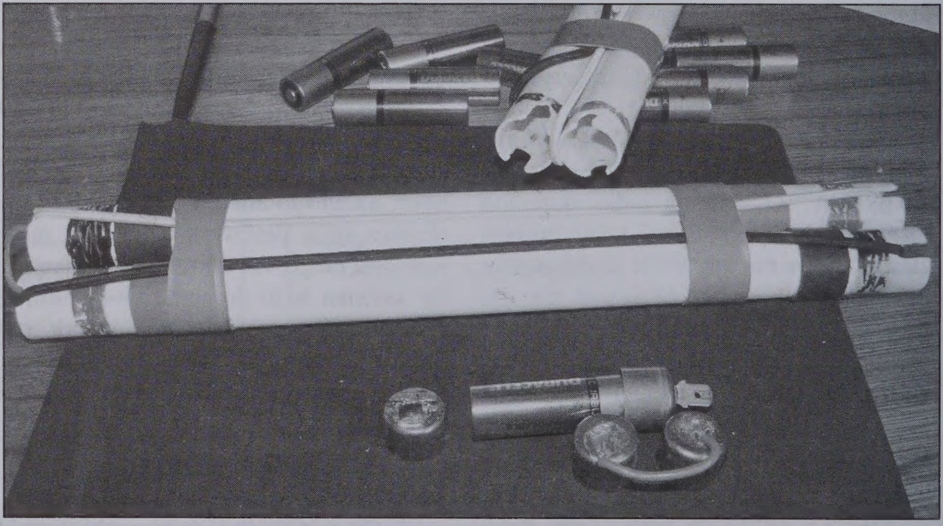


Figure 7—Assembled battery pack (center) and another awaiting assembly.

Control Circuit for Discrete Logic Counters

Originally titled "Control Circuit for Non-Microprocessor-Based Frequency Counters and Digital Dials" (which is too long for the table of contents), this was submitted by Bryant Zulstrom, KCØZNG.

A frequency counter determines the frequency of a signal by counting the cycles over a known time interval. A digital dial is a frequency counter that samples the local oscillator signal in a receiver or transmitter and adjusts the resulting count by the unit's intermediate frequency to report the receive or transmit frequency. These days such counters use microprocessors, as in the National RF dial (Ref 1), the NorCal FCC-1 (Ref 2), and others, but earlier units used discrete logic and those counters remain interesting and useful. For those who enjoy building and experimenting with counters that use discrete ICs, here is a control circuit that increases the proportion of time that such counters spend counting.

How Counters Count

Step into the Wayback Machine for a trip to the early 1970s. At that time, the heart of any frequency counter was a set of decade counter ICs like the 74160 or 74192. These chips counted the cycles of an input signal and presented the count in BCD [binary coded decimal] format. Other chips latched (held) the count and decoded it to drive Nixie tubes or 7-segment displays. Control circuits supervised the process: Count for a specified interval of time, like 1 second; stop counting and latch the count, which is displayed; reset the counters and count again. Digital dials used counter ICs that could be preset to non-zero counts. Amateur radio magazines contained many articles that described counters and digital dials using this structure.

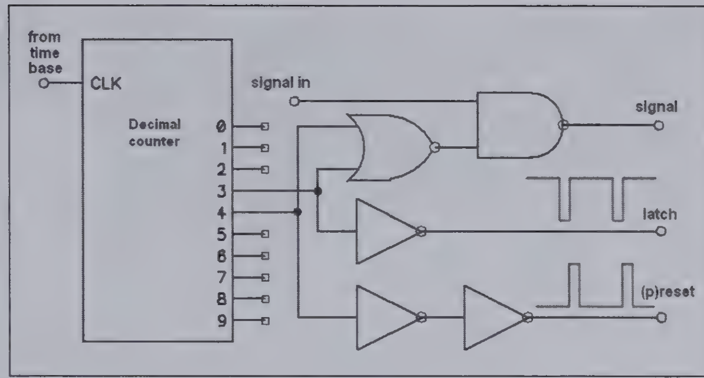


Figure 8—Using a decimal counter to generate control signals for a frequency counter.

Later, manufacturers developed ICs that combined various operations within a counter. For example, the ICM7217 contained a presettable four-digit BCD counter, latches, and multiplexed driver for a four-digit LED display. In all cases, however, a control circuit was required to set the counting interval and generate the latch and reset (or preset) signals.

Controlling a Counter

A typical control circuit begins with the time base: a crystal oscillator whose output is divided down to a low frequency, say 5 Hz. The last stage of the division is a single flip-flop, so that the output is a symmetrical square wave. When the output of this flip-flop is high, the counter counts. When it goes low, other logic generates a latch signal, and then a reset or preset signal. When the square wave goes high again, counting starts over. Thus the counter spends exactly half its time counting, a tiny bit of time getting ready to count again, and about half its time doing neither. For example, if the control signal is 5 Hz, then the counting and non-counting intervals are each 0.1 second.

A different use of the time base's signal can increase the proportion of time that a counter spends actually counting. A decimal counter accepts an input signal and brings one of its ten outputs high, in order, on each input cycle. Over ten input cycles, each of its outputs is high for 1/10 of the time. We can use two consecutive outputs

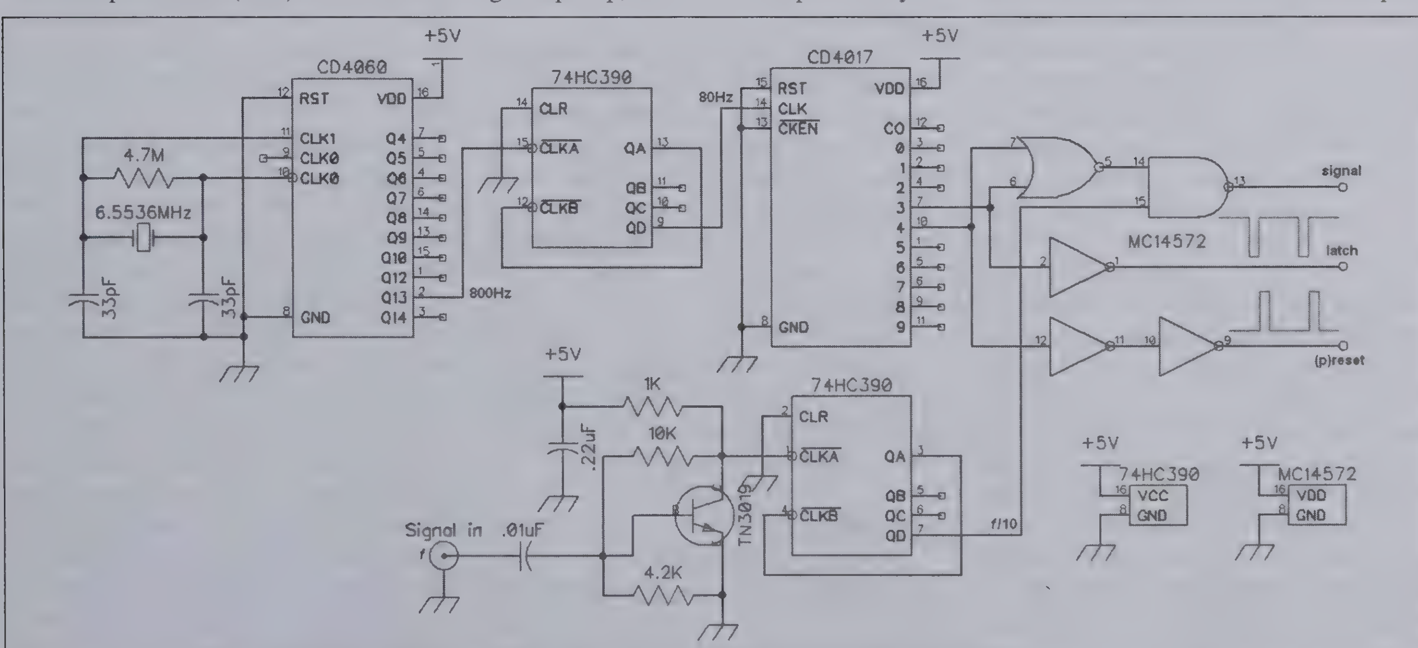


Figure 9—A signal input and control circuit for a frequency counter, using CMOS logic.

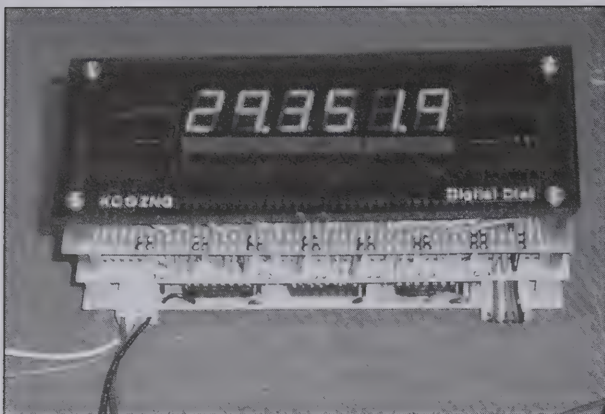


Figure 10—A digital dial that uses a control circuit similar to that in Figure 9.

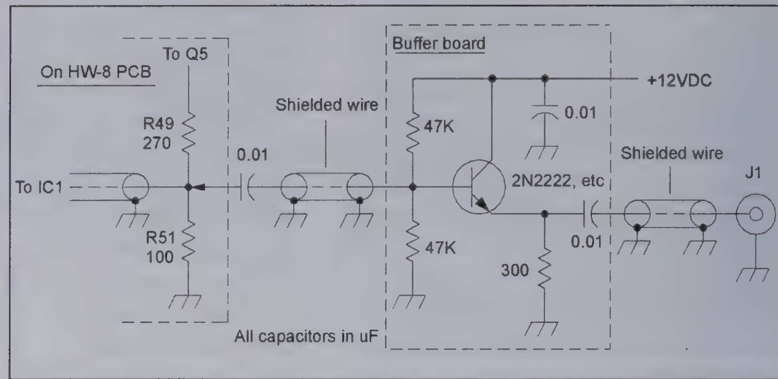


Figure 11—A buffer amplifier allows readout of HW-8 TX/RX frequency with a counter. J1 can be any convenient connector such as BNC, phono, etc.

to generate latch and reset signals, and when neither of these is high, the counter counts. Thus it counts 80% of the time rather than 50%. Figure 8 outlines an appropriate circuit.

When the indicated outputs of the decimal counter are both low, the output of the NOR gate is high, so the gated signal is transmitted to the counters. When output 3 goes high, counting ceases and the latch signal goes low. When output 3 goes low and output 4 goes high, no counting occurs and the reset signal (high) is sent.

Suppose that the input signal to the decimal counter IC is 80 Hz. The IC cycles through its outputs eight times each second, so that each output is high for 1/80 = 0.0125 second at a time. Counting occurs while two outputs are low (and one of the remaining eight is high), so the counting interval is $8 \times 0.0125 = 0.1$ second, and counting occurs eight times each second. Note that there's nothing special about outputs 3 and 4; any two consecutive outputs of the decimal counter will do.

Latch and reset signals vary with counter and latch ICs. The circuit in Figure 8 assumes that the latch signal is active low and the reset signal is active high. If this is not the case, rearrange inverters to make the signals right.

An Input and Control Circuit

The schematic of Figure 9, like Figure 8, was generated with the freeware version of the DipTrace schematic and PCB design software (Ref. 3) and Paint (part of Microsoft Windows). It shows a CMOS-based signal input and control circuit using these ideas. The CD4060 includes an inverter that can be used to make an oscillator and a sequence of flip-flops, so a 6.5536 MHz crystal yields an 800 Hz signal at pin 2. One section of a 74HC390, a dual BCD counter, divides this frequency by 10 and the resulting 80 Hz signal goes to a CD4017 or 74HC4017 decimal counter. A CD4572 gates the signal and generates control signals.

The signal input stage is taken from EMRFD (Ref. 4). The transistor can be any general-purpose small-signal type, such as a 2N2222 or 2222A. The transistor's output goes into the other half of the 74HC390, so that if the input frequency is F, the signal sent to the counting circuit is F/10. With a counting interval of 0.1 second, this effectively divides the input frequency by 100, which is appropriate for a six-digit counter whose output will look like this: xx.xxxx MHz.

The CD4572 (or MC14572) is particularly useful here. The control circuit requires a NOR gate, a NAND gate, and a few inverters (depending on the signals the counters and latches expect). One could use a quad-NOR and a quad-NAND, but the '4572 contains one NOR, one NAND, and four inverters, so it is perfect for this application.

Figure 10 shows a digital dial that uses an input and control circuit similar to Figure 9. In this unit, the counting is done by six 74LS196 presettable BCD counters, and the latch/drivers are 9374s.

Conclusion

Many variations to this circuit are possible while retaining the decimal-counter-based scheme. Any oscillator frequency and dividers can be used that yield a useful frequency at the decimal counter. The input signal may be divided by a larger value, or smaller. Other logic families contain chips with similar functions. However implemented, this control circuit will have a counter counting 80% of the time.

References

1. Ray Osterwald NØDMS, "Product review: National RF digital frequency display for vintage radio equipment," *Electric Radio* #217, June, 2007, pp. 40-41.

2. Bob Okas W3CD, "The NorCal frequency counter," FCC-1, *QST*, September, 2006, pp. 28-32.

3. http://www.diptrace.com

4. Wes Hayward W7ZOI, Rick Campbell KK7B, and Bob Larkin W7PUA, *Experimental Methods in Radio Frequency Design*, ARRL, 2003, pp.7-11.

—de KCØZNG

Frequency Counter Adapter for the HW-8

From Steve Ray, K4JPN, adapted from his web page—

The simple buffer circuit shown in Figure 11 allows you to read the actual transmit and receive frequency of the HW-8 with a DD-1 Digital Dial (made by Oak Hill Research) or any general-purpose counter.

I found that trying to take the output off the VFO directly and from several other places resulted in the counter clock getting into the receiver or the counter being sensitive to RF when the rig was keyed. The circuit was built on a piece of perf board and mounted on the inside back wall of the cabinet. Mount the input capacitor on the HW-8 circuit board at the junction of R49

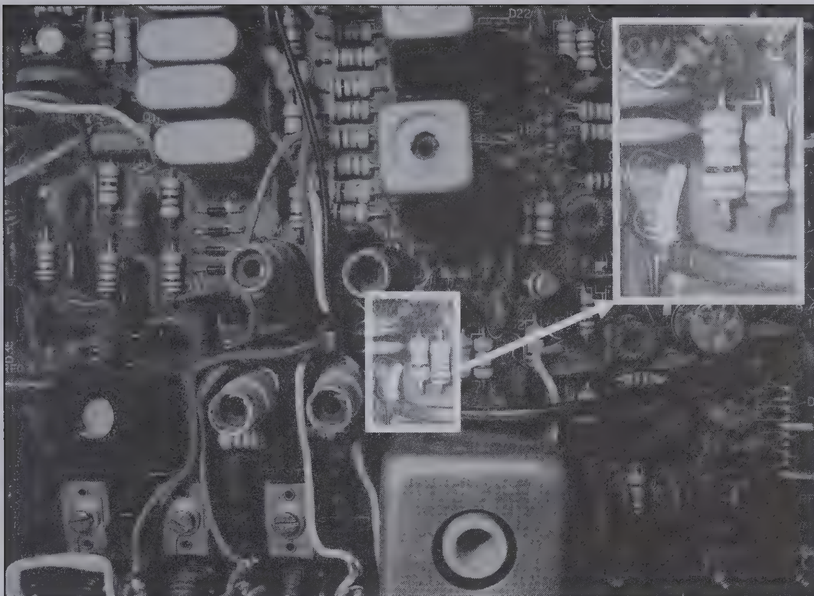


Figure 12—The two resistors are just behind the shield can of the VFO coil. (This is an unmodified HW-8.)

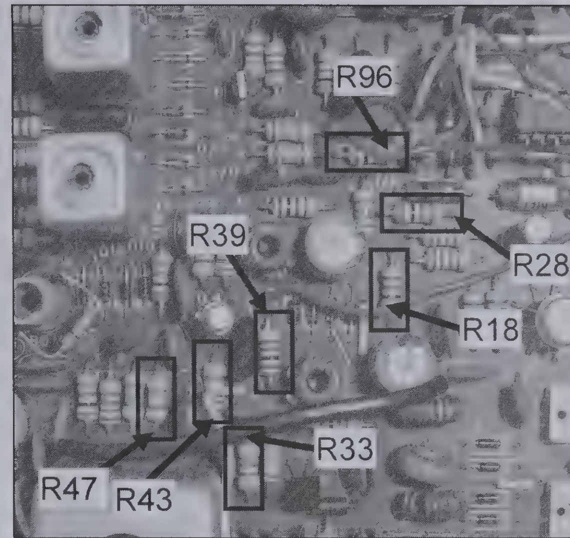


Figure 13—Some possible places to pick up power for the circuit. Connect to the indicated end of whichever resistor you decide to use, or connect to the power switch.

and R51; Figure 12 shows where to find them, behind the VFO inductor shield. Use the lead closest to the rear panel. (You can use either resistor.)

It is important that you use good shielded wire from the capacitor to the input of the buffer. It is also important that the shield be grounded at both ends. I found the lug attached at the VFO capacitor made a good ground for the shield at the input end.

[*WA8MCQ comment*—The lug is relatively far away and results in a rather long ground wire. You can also pick up a closer ground near the resistors. A shielded cable connected to points C and S on the board carries the signal from R49/R51 to IC1, the product detector. The added cable connects to the same place so you can use point S for ground, or the end of R51 closest to the front panel. R51 is on the left, value 100 ohms. The end closest to the rear panel is the junction of the two resistors.]

The output of the circuit should be mounted as close as possible to J1, which is mounted on the rear panel. As with the input, use good shielded wire grounded at both ends.

—de K4JPN

WA8MCQ comments: The HW-8 VFO covers 8645 to 8895 KHz. That can be displayed as X.000 to X.250 with any "digital dial" that allows programmable presets and offsets, but not on a general purpose counter. The signal at the junction of R49 and R51 is the output of the buffer following the mixer amplifier after the VFO has been mixed with the heterodyne oscillator (which uses 1 of 4 crystals) and is at the actual TX/RX frequency.

Power for the circuit can be picked up at any convenient point inside the HW-8. Figure 13 shows some possible points to tack on a wire; they are all on the same PCB trace. All of these have the full supply voltage when the power switch is turned on.

—de WA8MCQ

Class C Amplifier with I-Q Drive
From Mert Nellis, WØUFO—

I wanted to go retro by making an AM rig that had a class C final modulated with a high-level class B modulator. While experimenting with Class C finals, I came up with the idea of using the I-Q signals of a VFO to get a nice 90 degree pulse width to drive the final. The circuit shown in Figure 14 shows that AND-ing the I-Q provides a short pulse and also AND-ing the I´-Q´ provides the same short pulse but 180 degrees out of phase. If single sided

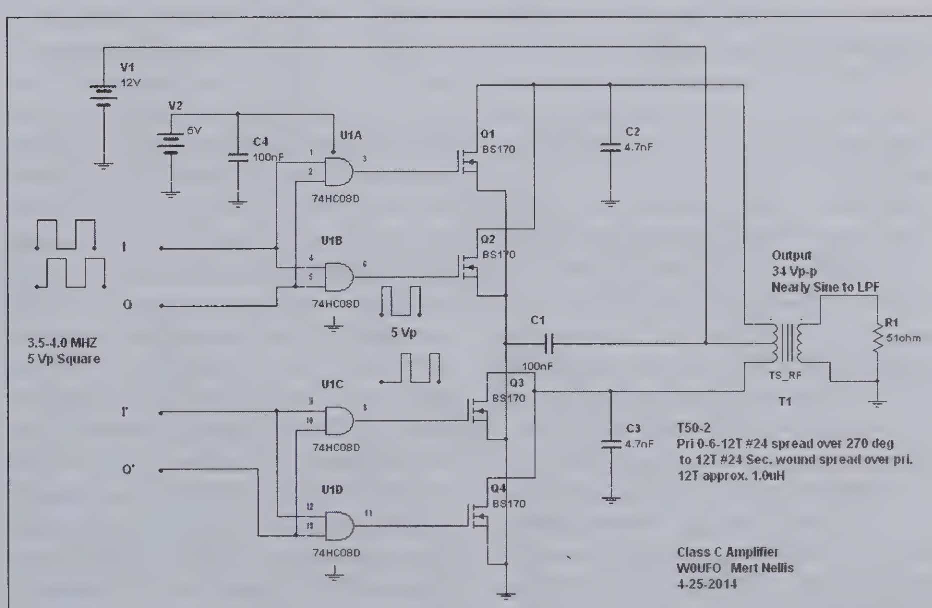


Figure 14—Parallel/push-pull Class C amplifier with I-Q drive.

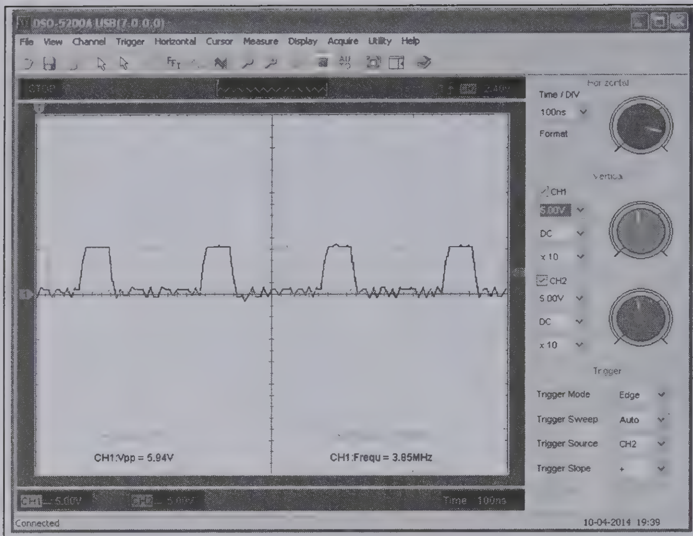


Figure 15—Oscilloscope screen capture of the I and Q drive pulses.

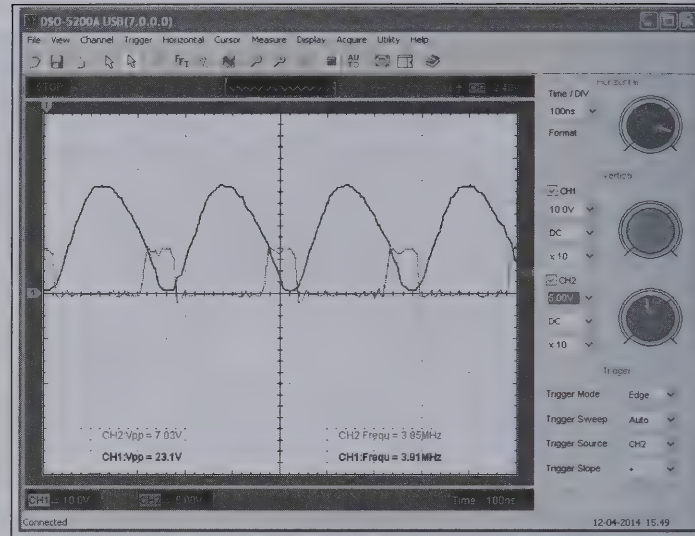


Figure 16—Drain voltage of a BS170 (sine) and drive pulses (square).

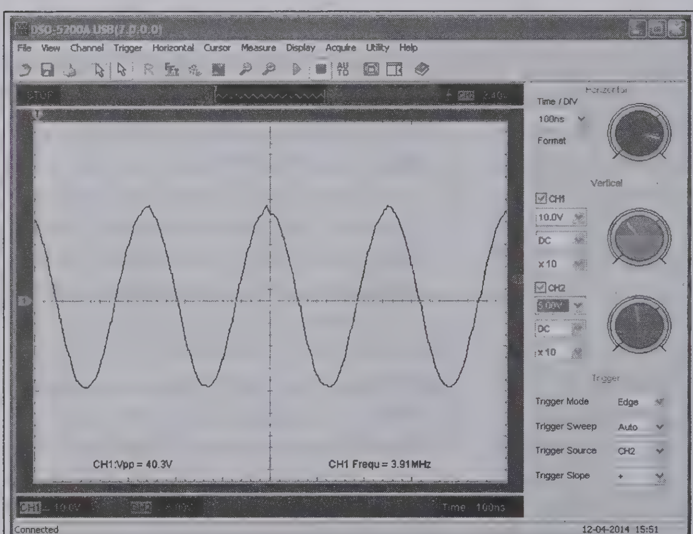


Figure 17—Output into 50 ohms following a low pass filter (not shown in the schematic).

operation is sufficient, use only an I-Q signal.

As long as the AND gate package supplied four outputs I decided to drive 4 BS170 MOSFETs in push-pull parallel as the circuit shows. The short pulse drives the BS170 ON for a short time and then stays off the rest of the cycle, allowing the L-C of the output circuit to "ring" in typical class C mode if the proper L-C ratio is used.

I assumed that a 50 ohm load would be coupled across the transformer primary and that a Q of 3 would be the loaded Q, giving a reactance of 16.7 ohms at the resonant frequency of 3.9 MHz, making L = 0.7 uH. Using a mini-ring toroid calculator, I checked out a T50-2 core and found that about 12 turns gave the required inductance with flux density below core loss limits with 17 volts RMS (48 Vp-p) applied. The transformer uses a T50-2 toroid with a 12 turn center-tapped primary and a 12 turn secondary wound over the primary. Both windings are spread over 270 degrees of the toroid.

The output power is about 3 watts with a 13 VDC supply. My goal was 2.5 watts. The output to 50 ohms is nearly a sinusoid but a simple low pass filter following it insures a low distortion signal.

Figure 15 is a screen capture of my USB scope showing the drive pulses. Figure 16 shows drive pulses (the square wave) and the drain voltage of a BS170 (the sine wave). The trigger source is channel 2, the drive pulse, and ground is at the center of the screen. Figure 17 shows the output into 50 ohms after a low pass filter (not shown in the schematic). As with Fig. 16, the square drive pulse is the trigger source and ground is at the center of the screen.

—de WØUFO

Scratchy Dot Reducer for Bugs

Although the technology dates from the early 1900s (Ref. 1, 2) and fully automatic electronic keyers have been available for decades (Note 1), semiautomatic keys or "bugs" are still popular. Dashes have to be made manually by pressing the paddle to one side, but pushing it in the other direction produces a long string of dots/dits. A problem that can crop up is scratchy dits; it can be caused by dirty contacts as well as mechanical issues.

The subject was discussed on the mailing list of the 4SQRP group (Note 2); the following was adapted from some of the posts.

From Jim Sheldon, WØEB (w0eb@cox.net)—

I have been hearing more bugs on the air lately, mainly amongst the QRO operators, and I've heard some really excellent sounding ones and some really horrible ones. I'm not talking about the operator's "fists," but the really scratchy dots inherent in the mechanical contact on the vibrating "dit" generator. This contact is usually at the end of a bent, flat spring and the cause of the "scratchies" is extra bounce on contact break, as the spring becomes free to vibrate on it's own as the contacts separate.

Ted McElroy, who held the CW receiving record for many years (and some say that record hasn't been officially broken yet), came up with a mechanical device that he incorporated into the contact assemblies on the bugs he marketed back

Figure 18—An add-on device holds a piece of stiff wire to keep a bit of tension on the spring for the dot contact. This one is mounted on a Vibroplex Blue Racer, which has a round pendulum.

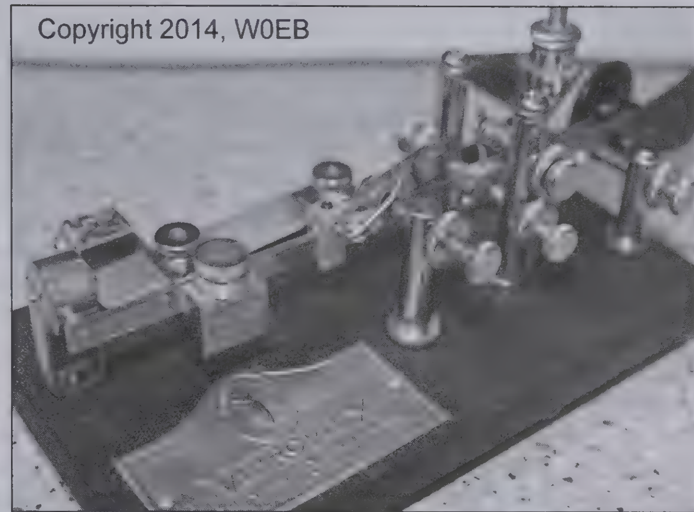


Figure 19—A slightly different design works with bugs having a flat pendulum.

in the 1920s and 30s. I've come up with a handmade version of this "dot contact stabilizer" that eliminates the need for a capacitor across the terminals of most bugs and almost completely eliminates the scratchy dot syndrome when it's properly adjusted.

The theory and pictures of the original McElroy device can be seen at

http://artifaxbooks.com/dotstabilizer.htm

Tom French, W1IMQ, who owns and maintains that historical site, graciously posted links to several pictures of the ones that I make, mounted on 3 different makes and models of my own bugs. You can find the pictures and links near the bottom of that page.

The main difference between the device I make and the original is the mounting. The original was integrated with the actual dot contact assembly and mine is designed as a retrofit add-on that doesn't require removal or a remake of the contact assembly itself. Either way, the theory is the same. A piece of stiff wire contacts the spring and keeps it under a small amount of tension at all times. Figure 18 shows my original design, made for bugs with round pendulums. Figure 19 shows one I designed later, for use on bugs that have a flat pendulum

You can even achieve the same results with a piece of light wire wrapped around the contact spring and the pendulum to supply tension. That's how I learned about this thing in the first place.

I've been using one on each of my 4 bugs and it makes them sound really good on the air (within the limitations of my fist) and it makes the bugs much easier to send decent CW with.

[WA8MCQ note—For those interested, Jim makes and sells these devices; see Note 3.]

—de WØEB

Although scratchy dits can result from bouncing contacts, there are other possible causes as well, and these issues should also be addressed. From Don Wilhelm, W3FPR—

Scratchy dits are usually caused by dirty dit contacts or improper adjustment on bugs. A piece of paper pulled through the closed dit contact can clean them; repeat until no further color appears on the paper. Adjustment of the damper to properly time the length of the dits with your dash sending speed is also important; the normal ratio is 3:1. Many (most) bug users I have heard make the dits too short in comparison to the dashes.

The spring tensioner can help with mechanically induced "scratchy dits" problems. One should still maintain clean contacts on bugs and straight keys, and also on keyer paddles. Regular maintenance will take care of the dirty contacts, but it will not help with the mechanical aspects.

—de W3FPR

From WØEB—

Even with clean contacts, the dits can still be scratchy due to the continued vibration of the spring contact as the contacts break (not on make). Ted McElroy figured this out early on, hence the device he added to his bugs, where it was an integral part of the dot contact spring assembly. I've done a lot of experimenting with this and it works, providing it's properly adjusted.

From Charles Moizeau, W2SH, who presents another way of dealing with the contact bounce issue—

After getting the contacts nice and clean (all four of them, dits and dahs), there are a couple more things to attend to.

When adjusting the dots, you're supposed to then be able to send a string of them that will end with the arm resting against its damper and the dot contacts closed to give you a very long dah. Many will try to see just how many dots can be sent before contact closure occurs. I used to engage in this game of skill and could get a couple of dozen dots sent.

The trouble is that the quality of the later dots becomes somewhat irregular with such an extreme adjustment. It is therefore best to make your adjustment to get just 10-12 dots and then have contact closure. Such a lesser number will give you an adequate series of decent dots with a single thumb poke for any conversation,

and only eight are needed to flag an "error".

Then there is the matter of contact bounce and that results from the absence of any damping of the horseshoe shaped leaf spring that supports the movable dot contact. I completely solved that problem by getting a small piece of very finely grained plastic foam, something your local jewelry store discards from the packaging when they sell a watch or piece of jewelry. Cut a very small piece just long enough to fill a bit more than half of the space inside the horseshoe spring. When it is wedged within the spring, the foam should fit loosely but securely enough to remain in place without any adhesive.

—de W2SH

From WØEB—

The technique of using a piece of high density foam will cure many of the problems, but not all foam is created equal. While certainly cheaper, it doesn't always work in all instances as I found from over 6 months of experimenting. Quite by accident I found the information on the artifaxbooks.com site and then decided to attempt a resurrection of the damping device.

The ones I originally made were specifically for the Vibroplex, Speed-X and McElroy keys that have the round pendulum that the weights slide on. At the time, I did not make them for those with the flat pendulum such as the Vibroplex Lightning Bug, Champion or the old military J-36 bugs. I did, however, have a prototype in "beta test" that I believed would fit the flat pendulum keys and it turned out well. I now also offer them for those models. (See Figure 19.)

From Randy Drake, KB4QQJ—

The WØEB device works very well and is definitely better than the high density foam. I have two McElroy bugs that use it and it makes a noticeable difference. The contacts are always kept clean with Vibroplex cleaner strip. However, not as good as this device but much better than the foam is the thick shelf liner you get from any supermarket, Bed, Bath & Beyond, etc. Get the one with the round dots on it.

It works far better than the foam. Fold it over double for Lightning Bugs and the J-36. But it's still not as good as the revived damping device. I'm glad to see someone pick that up.

By the way, a piece of the shelf liner placed under the bug makes it stay put like glue.

—de KB4QQJ

References and Notes:

Ref 1. http://www.telegraph-history.org/bug/index.html

Ref 2. http://www.radioblvd.com/telegraph_keys.htm

Note 1. Fully automatic keyers, even solid state ones, date back over 5 decades. I built my first non-tube keyer when the April 1968 *QST* came out, with an article about making one with just 3 ICs. A bit of research in the online *QST* archives shows that the solid state Heath HD-10 keyer was reviewed a year before that.

I eventually found an article in the May 1959 issue describing a solid state keyer which was presented as a transistorized version of the fabled W9TO vacuum tube keyer. Old timers will fondly remember that as the "TO keyer." (The *QST* article noted that, as far as they could determine, the original vacuum tube circuit had never been published in a periodical and apparently was passed around from person to person.)

One of the co-authors of the 1968 article—Dr. Ronald Stordahl, KØUXQ then, AE5E now—later offered a kit of parts to make the keyer, calling it the "Digi-Key." That effort eventually morphed into the well known company of the same name.

Note 2. The Four State QRP Group started out for hams in the region of Arkansas, Kansas, Missouri and Oklahoma, although the group has since grown and picked up people from a much wider area. Their website can be found at http://4sqrp.com and the discussion list, which is open to all regardless of location, is hosted by yahoo.com. The home page can be found at https://groups.yahoo.com/neo/groups/4sqrp/info.

The club has produced a number of popular QRP related kits. They also have a monthly online newsletter called the Ozark Banner, available on their website as PDF files. All back issues are available; there are currently about two dozen. (Several articles from it have appeared in this column.)

Note 3. If interested in one of the devices that Jim makes, you can contact him at the e-mail address above or by snail mail: Jim Sheldon, 2029 East Evanston Dr., Park City, KS 67219-1618. Be sure to specify what model bug you want it for, since some may require a slightly different design.

He said, "I've decided to market them on a limited basis as I have to hand make each one I'm not looking to get rich selling them, but I've hit on a $20 postage paid price per device within the US and $20 plus whatever shipping costs for international customers on a case by case basis. They are made mostly of aluminum bar stock with a couple of setscrews and the adjustable piece of music wire to tame the contact. Included in the price are complete adjustment instructions and the proper Allen wrench for the set screws."

The Fine Print

You know the drill—send your info to Severn any way you can get it here (e-mail, snail mail, 3 1/2" floppy, CD, handwritten on a napkin, etc), or tell me where you found something of interest on the Internet.

Well written, Pulitzer Prize quality articles are nice, as are computer drawn schematics, but don't worry if you can't do all that. We'll take care of the rest, editing, redrawing, etc. The readers are waiting!

2014 QRP ARCI Contest Calendar

6 July 2014 — Summer Homebrew Sprint
23 August 2014 — Welcome to QRP
6 & 7 September 2014 — The Two Side Bands Sprint
11 & 12 October 2014 — Fall QSO Party
27 November 2014 — Top Band Sprint
14 December 2014 — Holiday Spirits Homebrew Sprint

Get on the air and join in the fun!

CW Sender: Part II

Ben Kuo—KK6FUT kk6fut@verizon.net
Pete Juliano—N6QW radioguy90@hotmail.com

In our first article, we provided an introduction to the Arduino microcontroller, a handy device which can easily be incorporated into your QRP radio projects. Part I included explaining the use of the "sketch" and code development for generating the letters "CQ". Part II will focus on building real hardware, using the Arduino to build your very own, CW "bug".

If the readers have not done so as yet, this is the time to build the breakout board described in Part I (www.jessystems.com/arduino_build.html). Since Part II requires quite a few connections to the Arduino, the breakout board will be "key" to make your project a success.

In Part I, we developed the "CQ" characters using the LED On/LED Off functionality of the Arduino Uno R3. Turning an LED On and Off is fun for about 30 nanoseconds and then it becomes boring. So, Part II has as a goal to "build" something useful like a CW bug and to program the Arduino to generate CW based on inputs from the bug and even key your favorite QRP transmitter. We will also introduce concepts such as function calls, timing routines, reading input states and utilizing the analog inputs, all of which we'll use to build our CW bug—and which, in the future, will enable the development of canned messages such as you might have with a contest keyer.

For those fortunate enough to own a CW key such as the venerable WWII surplus J-38 straight key, sending readable high speed CW (like at 20 WPM and beyond) is an art that not many master. Long ago, commercial high speed CW ops learned that lesson and many innovations to the straight key soon appeared on the scene. Enter the BUG where the dits and dahs are separately mechanically generated. In our project, we've applied the Arduino to this task, as the perfect device for "cleaning up" CW that is mechanically generated so the 20 WPM sounds like it should.

We will develop a version of the bug, called by old timers "a sideswiper". As shown in Figure 1, it is made from common components such as small 3/4 inch round magnets, a hack saw blade, several metal L brackets, two metal spacers, round wooden decorative plugs, a wood block, scrap PC board and some hardware, all of which are shown in Figure 2. A trip to Home Depot and a $10 bill will purchase most of these components. Centering of the blade is done with the magnets in a repulsion arrangement and while the final result is not chrome plated, nor does it look as nice or as silky smooth in operation as a commercial key, the homebrew bug is fully useable for normal daily use. Embedded in the N6QW website, http://www.jessystems.com/arduino_build.html are several short videos of the Sideswiper and Arduino being used to electronically generate CW.

So we don't take up valuable print space with the detail of the "sideswiper" construction, complete step by step instructions for building the bug are contained on the N6QW website at www.jessystems.com/arduino_build.html.

Adding Sound to Your Lights

To improve our project and help with debugging, we're going to first add sound. There are two requirements for adding sound to any Arduino project and the first, of course, is an output device such as an 8 ohm speaker or headphones that typically are used with the IPOD, Sony Walkman, etc. Most of these earbud type headphones are 32 ohm and so you will see some reduced output. It is not good practice to simply connect the headphones or speaker directly to an Arduino output pin, because the output is essentially a square wave connected to an inductive load, so a 100 ohm resistor is inserted in series with the Arduino output pin and the speaker/headphone terminal to protect both devices. The other end of the speaker or headphone is connected to ground. What may not be realized is that with the added tone, our keyer project now has a built in sidetone!

The second requirement is a "tone library". As you will recall from Part I, libraries are software subroutines that enable the Arduino to perform specific functions which for this application will generate a specific tone close to 700 Hz.

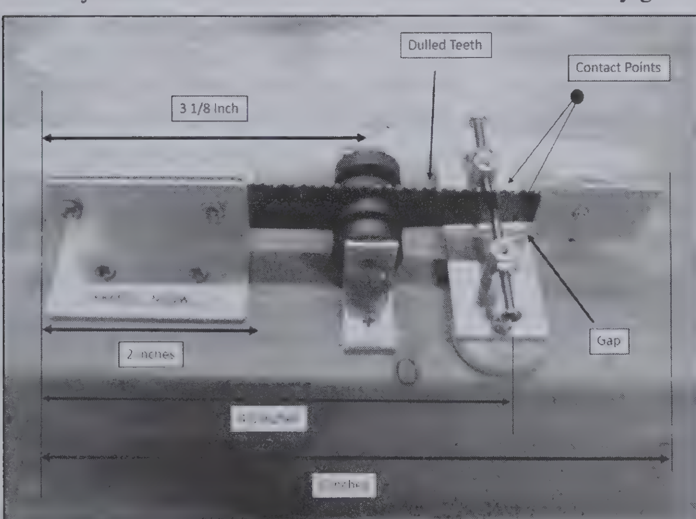


Figure 1—The homebrew sideswiper key.

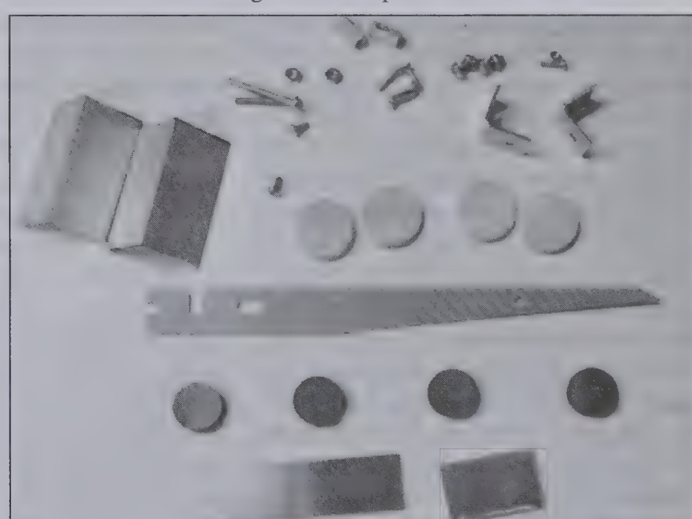


Figure 2—The collection of parts to make the bug.

```
void senddash() {
  digitalWrite(LED, HIGH);
  tone(10,NOTE_F5);
  delay(dashdelay);
  noTone(10);
  digitalWrite(LED, LOW);
  delay(dddelay);
}
```

Figure 3—Code to send a dash.

```
void senddot() {
  digitalWrite(LED, HIGH);
  tone(10,NOTE_F5);
  delay(dotdelay);
  noTone(10);
  digitalWrite(LED, LOW);
  delay(dddelay);
}
```

Figure 4—Code to send a dot.

```
void loop() {
  sendash(); // C
  senddot();
  sendash();
  senddot();
  delay(chardelay);
  sendash(); // Q
  sendash();
  senddot();
  sendash();
  delay(worddelay);


}
```

Figure 5—Using functions to send CQ.

The tone library is included in the standard Arduino environment, and if needed, can be downloaded from the Arduino website at the following link, http://arduino.cc/en/Reference/Libraries.

When the libraries are downloaded they must reside in the Arduino library directory on your computer so when the Sketch is loaded on to the Uno R3 that information is loaded along with the other code which tells the Uno how to respond. In addition to the libraries, specific code must be written in the Arduino sketch to establish the specific output tone frequency and to "call" for the tone to be generated. Later we will detail how this is done.

Using Your Bug To Send CW

Once you have the hardware built, here's where we use the power of the Arduino to make your new homebrew bug send out perfect CW. To do that, we use two signals from the bug—the two contacts on your bug on either side of the center metal blade, and feed those into two of the inputs on Arduino. When the bug is pushed to either side (right or left), this connects the center blade to the appropriate contact, which is in turn electrically connected to two separate inputs of the Arduino. Within the Arduino software, we'll use the presence (or absence) of a signal here to determine if you wanted to send a dit, a dah, or neither.

In addition, we'll use two potentiometers as a direct control over two of the key variables in sending out CW: the words per minute speed, and the spacing between dits and dahs, all by turning those pots. We take advantage of another, handy feature of Arduino—reading an analog value—to convert the position of those pots into a digital number and using that in software.

First, Function Calls

However, before we get into the nitty gritty of hooking this all into hardware, a bit of explanation is in order. One of the key advantages of software is the ability to reduce complex, repetitive tasks into simple, repeatable blocks of code. Those are called function calls. In Part I, to send out "CQ", we ended up copying-and-pasting code many times. Although it's great for learning, copying and pasting code willy-nilly will only lead to anguish and lots of time spent pulling out your hair trying to figure out what isn't working in software. Instead, to make this easiergand help develop your software skills—we'll be reducing that repeated code into two simple functions: senddash() and senddot().

Function calls are essentially blocks of code that can be called, repeatedly, and which do the same thing every time—or potentially can do things slightly different given a different input. In our case, we're creating two simple functions to do the repeated operations of sending out a dash, and sending out a dot. To do that, we simply take the code we were using in the sketch for part I, and create two different variants on that code to correspond to sending a dash or a dot.

To use those functions elsewhere in our Sketch, we just need to call them by including the function name followed by the open and close parenthesis.

How senddash() works

The function displayed in Figure 3 is senddash(), which—if you examine the first article in this series—will look very much like the code we had been copying and pasting to send out a dash. Essentially, we use the function call digitalWrite() to set our LED output to high, add a delay determined by a variable, dashdelay, to wait, and then set our LED input back to low. We then wait a predetermined amount of time (dddelay) to pause between our dots and dashes.

You'll note two new function calls we did not use in our first article: tone() and noTone(). These two function calls are the ones we added by using the tone library, and allow us to play a tone to a speaker. tone (10,NOTE_F5) says to play a tone on pin 10, of frequency NOTE_F5 (which is a value in hertz of F5). noTone(10) is used to tell the software to NOT play any tone on pin 10, after we wait for some amount of time while the tone plays. Note the Arduino reference library for tones has decoded the various tones to tone frequencies in hertz. If another tone is desired simply change the code.

Sending a dot with senddot()

Now, if you examine the senddot() function in Figure 4, you'll see this is essentially the same function as senddash() except we use a different delay between setting our pin high and playing our tone, and setting the pin low and turning off the tone. That delay is from the variable dotdelay, which we have calculated to be the amount of time a dot should occupy in milliseconds.

Why bother with these functions?

At this point, you might be wondering —why all the complexity here, and why are we putting all this into functions, rather

```
void senddash() {
  digitalWrite(LED, HIGH);
  digitalWrite(relay, HIGH);
  tone(10,NOTE_F5);
  delay(dashdelay);
  noTone(10);
  digitalWrite(LED, LOW);
  digitalWrite(relay, LOW);
  delay(dddelay);
}

void senddot() {
  digitalWrite(LED, HIGH);
  digitalWrite(relay, HIGH);
  tone(10,NOTE_F5);
  delay(dotdelay);
  noTone(10);
  digitalWrite(LED, LOW);
  digitalWrite(relay, LOW);
  delay(dddelay);
}
```

Figure 6—Adding pin 11 for the relay.

```
void loop()
{ dotstate = digitalRead(dotpin);
  dashstate = digitalRead(dashpin);
  if((dotstate == LOW) &&(dashstate == HIGH)){ // dot key pressed send a dot
   senddot();
  }else if((dashstate == LOW)&&(dotstate==HIGH)) {
     senddash();
  }else{
    noTone(tonepin);
    delay(dddelay);
  }

}
```

Figure 7—Polling the inputs for dot, dash or none.

than just copying and pasting our dot and dash code to do what we want? If you examine Figure 3, you'll start to understand why. In our first article, to send the character "C", it took 17 lines of code. In this case, it's only 4 lines. To send out "CQ" by copying and pasting our original code, it would be upwards of 40 lines—versus only 10 lines here. Plus, we are less likely to make a mistake calling a function than having to copy and paste the same block of code over and over. In future articles, we'll show how we can eventually make a single function call to send any character we want, making things even more efficient and easy to read. We will show how to send "CQ" simply by: sendchar('C'); delay(x); sendchar('Q'); delay(x). [After that we'll show sendcharmessage[], such as you would have with a contest keyer. Stay tuned!]

Adding A Reed Relay

As a quick aside, while we were developing this project, we decided on adding another pin to trigger a relay—so that this Arduino can be connected to your favorite QRP radio, and actually be used as a CW key via a reed relay. To do this, we've assigned a new pin to trigger the relay, and made some appropriate code changes to support that relay. Revised code for our senddash() and senddot() software, and the schematic in Figure 8 also includes details on the hardware connection for that relay and the N6QW website has the P/N and source for the relay.

The code involves designating Pin 11 as an output and when "high" provides a source voltage to the reed relay which closes very quickly in response to the dits and dahs being generated. The 10 ohm resistor is needed to provide a load in the event of a coil short. The diode acts as a "back emf snubber", which is always a good practice for any relay coil. The reed relay was chosen over a simple solid state switch which can be problematic if keying an older vacuum tube QRP transmitter.

Checking Inputs

So, now that we're able to send a dash and a dot, we need to adapt our loop() code to check the two signals we are reading from our bug, to determine if we're supposed to be sending a dot or a dash—or nothing. To do this, we will read the values from the two inputs, pin 8 for the dash input and pin 9 for the dot input. We can then use some if-then logic to figure out what we ought to be doing.

The logic works as follows: We look to see if pin 8 has been grounded by our sideswiper key, in which case a "dash" should be sent, or if pin 9 has been grounded then a "dot" should be sent. If neither side of our key has caused either pin 8 or pin 9 to be grounded, then we do nothing. Note: if both sides are positive, we have a problem—or a short—because you should not be able physically have the center of the bug on both sides as the same time! If a programming loop continuously keeps looking through the three logic possibilities (dot, dash, nothing) on a fast enough schedule, then code can successfully sent at any speed we want.

In a group of new CW students, the question continuously comes up, "Which connector on the bug should be sent to which terminal on the keyer?" The correct answer is "Connect it so that it is comfortable to you." Classically, in the days of the mechanical, spring driven, semi-automatic key, the answer was that the bug was connected such that the sender's thumb caused a series of dots and the forefinger caused a dash. Since most operators were right-handed, this meant pushing the thumb toward the right to take advantage of the spring contact for dots and pushing the forefinger toward the left to manually make each dash. Most bugs were then right-handed. Now however, there is no need for shaping paddles differently as on the old bug and it is easy to change connections so that it suits you. The connections can easily be reversed if necessary.

Translating Input into a string of Dots or Dashes

Now, since we know if we ought to be sending a dot or dash, we can add some code to our if-then code to send out a dash (plus a pause). Initially, we're "hard coding" some values of the length of the dash and dot to make it easy; for our next step, we'll make it so you can change those lengths using a pot.

The way the logic in the code works, we do the following every time we go through the loop:

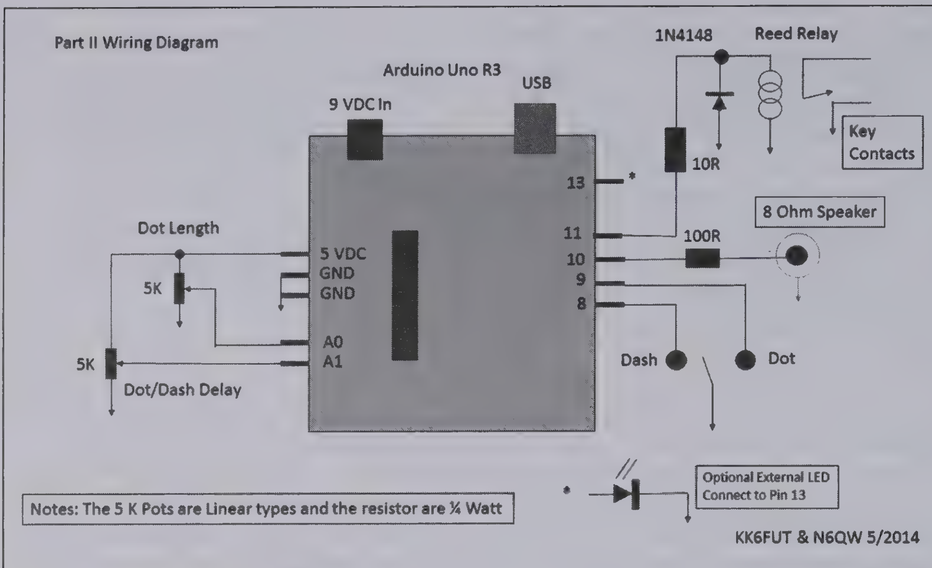


Figure 8—Wiring diagram for Part II of this project.

1. Check to see if we should be sending out a dash, a dot, or nothing.
2. If the bug is electrically connected to the dash side, send a dash and pause.
3. If the bug is electrically connected to the dot side, send a dot and pause.
4. Continually repeat.

In Figure 7, we've included the code which implements the steps (algorithm) we described above.

We first use digitalRead() to read the state of the two pins we have connected to dot and dash. We store these in two variables—dotstate and dashstate—to make it easier for us to examine and use these.

We then use what is called an if-then loop—one of the basic logical constructs in programming languages—to make some decisions, using some simple comparison operations and math. Here's where we basically check for the high/low signals (use the "==" operation) and choose whether we send out a dot, send out a dash, or do nothing.

The "else" part of the code is used to add additional conditions to check—such as another "if" condition, in this case to check if we need to send a dash, or if nothing else matches—in which case, we do not send out any values or set any pins, and wait.

Once this is working, you actually have a working bug! However, this has one big limitation: you can't adjust the length of dots or dashes, or the length of pause between dashes and dots, which as we all know you have to do to match the speed of whoever has answered your CQ, or whoever you are trying to contact. We'll fix that in the next part of the project.

Changing the Dots and Dashes

Finally, we polish off this project by letting you change the speed and length of the dots and dashes in our bug, by twiddling two different potentiometers. In Figure 8, you can see how we've wired up the potentiometers to Arduino.

We're taking advantage of one of the powerful features of Arduino: analog input. The Arduino Uno, which we've used for our projects in this series, allows you to connect analog components such as potentiometers, photosensitive resistors, resistors used in a voltage divide circuit, and more so you can determine things like voltages and/or values from analog circuits. (You can read more about analog input on the Arduino site at http://arduino.cc/en/Tutorial/AnalogInput).

For our project here, we've connected two potentiometers to Arduino, using pins A0 and A1. We'll now add some code to read the value of those potentiometers, and translate that into a value we can use in software.

[A detailed parts list, P/N and source are listed on the N6QW website Arduino link.]

IMPORTANT note: for those of you (especially N6QW) used to carefully calculating resistor values for a circuit—forget what you've learned! We're taking advantage of the software to handle all of the scaling, and can even use the software to arbitrarily change the range of values we need—all without touching the hardware. [For those so interested if you do want to calculate resistor values to limit the dot length and dot dash delay requires a three equation with three unknowns solution for each pot.]

Once we have all the hardware connected, we can add our code to read the pins.

This is quite simple, by using the analogRead() function. analogRead() allows us to poll the value of an analog input, returning a value between 0 and 1023. Those values correspond to a voltage level of between 0 and 5 volts.

Next, once we've read that value, we do some simple math in hardware to translate that value of 0 and 1023 to the milliseconds of delay for the length of a dot or dash. IMPORTANT: Math in an embedded system like Arduino can be very complex. It's important to understand how this code is constructed.

The code to do this for our first pin is shown in Figure 9.

It's important to note a few "tricks of the trade" here relating to how math is done on the Arduino. It's very, very, very important to make sure you have what is called the type of the variable you are using for these calculations correct. We've chosen a type of long which lets us store up to 32 bits (4 bytes) of numbers, for a range of –2,147,483,648 to 2,147,483,647. The authors did quite a bit of "debugging" early in developing this article because we had used a type of int, which on the Uno only allows for 16 bits (2 bytes) of number —for a maximum range of –32,768 to 32,767. If you look at the values we are calculating, you'll see that multiplying 1024 by 250 would be 256,000, which is far greater than 32,767. What happens with Arduino (and any software) is a register overflow, which means that you will not get what you expect from your software!

The second "trick of the trade" is paying attention to the order of operations in our math. Because we are multiplying and dividing with longs, there are not fractions or decimals involved! This means that if you divide a number smaller than 1024 before multiplying, it will always be zero (because we can't represent fractions in a long). So, we have to multiply our value

```
// first check analog inputs for changes
int dotval = analogRead(analogPin1);    // read the input pin for dot length
dotdelay = ((dotval * 250L) / 1024) + 30;  // scale our input to be between 30 and 280 milliseconds of delay
Serial.print("dotdelay is"); Serial.print(dotdelay); Serial.print("\r\n");
```

Figure 9—Software scaling of the Analog Input.

```
int delayval = analogRead(analogPin2);    // read the input pin for delay between dots/dashes
dddelay = ((delayval * 250L) / 1024) + 30;  // scale our input to be between 30 and 280 milliseconds of delay
Serial.print("dddelay is"); Serial.print(dddelay); Serial.print("\r\n");
```

Figure 10—Adding the dot dash delay.

```
void loop()
{

  // first check analog inputs for changes
  int dotval = analogRead(analogPin1);    // read the input pin for dot length
  dotdelay = ((dotval * 250L) / 1024) + 30;  // scale our input to be between 30 and 280 milliseconds of delay
  Serial.print("dotdelay is"); Serial.print(dotdelay); Serial.print("\r\n");

  int delayval = analogRead(analogPin2);    // read the input pin for delay between dots/dashes
  dddelay = ((delayval * 250L) / 1024) + 30;  // scale our input to be between 30 and 280 milliseconds of delay
  Serial.print("dddelay is"); Serial.print(dddelay); Serial.print("\r\n");

  // now check if we need to send a dot, dash, or nothing
  dotstate = digitalRead(dotpin);
  dashstate = digitalRead(dashpin);
  if((dotstate == LOW) &&(dashstate == HIGH)){ // dot key pressed send a dot
   senddot();
  }else if((dashstate == LOW)&&(dotstate==HIGH)) {
     senddash();
  }else{
    noTone(tonepin);
    delay(dddelay);
  }

}
```

Figure 11—Loop code finalized.

first by 250 then divide, in order to have meaningful results. [For those of you who went to school in the Dark Ages like N6QW, you learned about My Dear Aunt Sally—Multiply, Divide, Add and Subtract which even works in the Digital Age.]

Serial Port for debugging

You'll also notice in the code we've included our first use of the serial port, using the Serial library. Since we're now starting to add some fairly complex code, a useful technique used in software is outputting information about what the software is doing via the serial port. We've done that here to make sure that the values we are calculating for our delays actually are what we expect. This requires a little bit of work in our setup() routine to initialize. For those readers still using Windows XP built into to the accessories is a hyperterminal. Open up the hyperterminal and set the port for Com1 and the baud rate for 19200 and you are there. For those using a later OS such as Windows 7 then you will need to download a free program such as puTTY from this link. http://www.putty.org/. The website link details how to set up puTTY with the appropriate data so that the screen will display the information from the serial port.

Now that we've figured all of that out, we are going to use the second analog pin to control the length of the pause between each dash or dot. In Figure 10, we add another read of our second pin for our value.

Finally, we wrap this all into our original loop code for the keyer shown in Figure 11.

For completeness, there's a bit of setup required in our code to make sure all variables are declared and registers set up, the code as shown in Figures 12 and 13.

The N6QW website has the complete Sketch for Part II in notepad format. Copy the code data into a new Sketch and save it as CW_PartII. Follow the usual steps to compile the code and load it onto your Arduino and get set for some fun. The serial port lets you see the action of the dot delay and enables you to reset a value that most fits with your sending speed. Since this article is aimed at the low to medium

```
#include <toneAC.h>
#define NOTE_F5  698

const int LED = 13;
const int relay = 11;
const int tonepin = 10;  // Speaker on PIN 10
const int dotpin = 9; // dot key into PIN 9
const int dashpin = 8; // dash ley into pin 8
const int analogPin1 = A0;
const int analogPin2 = A1;

long wpm=15;
long z = 1200/wpm; // convert wpm to milliseconds
long dashdelay = 3*z; // length of a dash
long dotdelay = z; // length of a dot
long dddelay = z; // length of pauses between dots and dashes

int dotstate = LOW;
int dashstate = LOW;
```

Figure 12—Setting up the Variables and Constants.

```
void setup()
{
  pinMode(LED, OUTPUT);
  pinMode(tonepin, OUTPUT);
  pinMode(relay, OUTPUT); // keying the transmitter with this pin
  pinMode(dotpin, INPUT);
  pinMode(dashpin, INPUT);
  digitalWrite(dotpin, HIGH);  // turn on pullup resistors
  digitalWrite(dashpin, HIGH);
  Serial.begin(19200);

}
```

Figure 13—Designating inputs and outputs.

speed operator the max speed has been set at 15 WPM. Changing the line of code long wpm = 15; to some value such as long wpm = 35; will certainly give you a buzz cut. For those just starting out then long wpm = 8; will certainly slow things down a bit.

Conclusion and Next Steps

In this article, we've gone from a simple program which just sends C and Q using dots and dashes, to using function calls, taking analog input, and using such techniques as Serial port functions and some advanced math. All of that gives us a working "bug" and our first, radio-connected Arduino project. Figure 14 is a photo of the Part II project in its final form. It is quite a leap from LED On LED Off, but now gives us a platform which can be further enhanced—including adding an LCD screen, remembering sequences of CW, automated keying, and much more, which we will cover in our next article.

Stay tuned!

—de KK6FUT and N6QW

Note:

Part I of this series appeared in the Spring 2014 issue of *QRP Quarterly*.

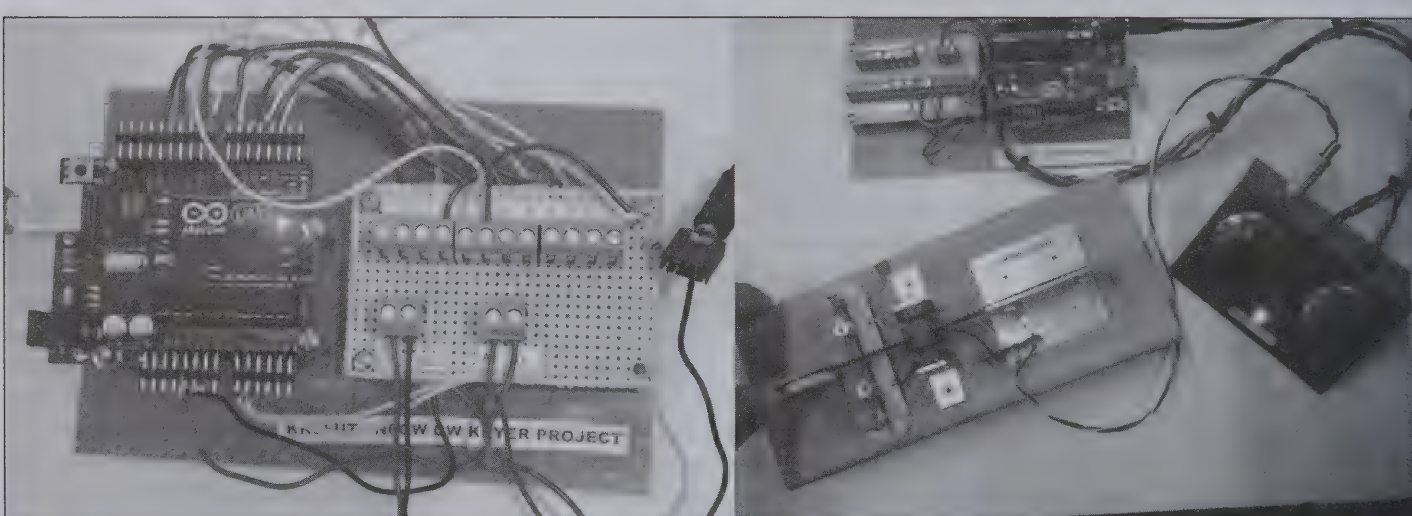


Figure 14—Photos of the Bug and Arduino board.

Out and About with QRP

Craig Behrens—NM4T craigb44@msn.com

FDIM, QRPTTF, AlexLoop and Coming Attractions

Last quarter's column started with comments about severe winter weather. As I write this one, daily thunderstorms are wreaking havoc here in the south.

We have been locked into a weather pattern that has made our Alabama W1AW/4 and Alabama QSO Party activities quite a challenge. A week ago, seventy-mile-an-hour winds knocked down three more of my trees, so I've been busy clearing the mess created by these storm events.

Such storms and antennas don't get along well. Many who subscribe to that old amateur radio adage that declares, "If an antenna stays up, it's obviously not big enough" as part of their quest to have optimal contesting and/or DXing stations are paying a dear price these days of extreme climate changes.

Often, we QRPers push our portable antenna implementations beyond their practical limits in the field. It's too easy to overlook (ignore) the same laws of physics that the "big guns" combat by using antennas that are structurally not sound. So, as part of this and future columns, we'll explore ideas for making smarter trade-offs regarding what we can (and should) do with portable antennas in field operational environments.

But first, I would like to join you in thanking the QRP ARCI staff for providing another fantastic Four Days in May event. Such success does not happen by accident—many invest a lot of planning and hard work to bring this joy to us!

Kudos also go to all those who volunteered, jumped into the fray to help us make it all happen. We had outstanding support this year!

Second, since my forum ended with a lot of Q&A, so we didn't get to introduce the two celebrities who help me deliver my presentation, The Great Arduino, JT-65 and Rebel Caper, High adventure with new radio paradigms.

I asked Martha Auchard, WØERI, to play the role of the witness who was there when the initial challenge that launched the caper occurred (Figure 1).

Those who have seen Martha in SOTA operations know that her underlying soft-spoken, unassuming appearance hides a person who truly loves radio adventures. As a point in case, consider this—being awarded "Super Sloth" status in 2014 by racking-up more than 10,000 SOTA points is an excellent accomplishment! So thanks again, Martha, for helping me get my forum started with a bang.

Glen Popiel, KW5GP, performed the "shifty" skunk role (all too well). He helped us reveal how the QRP Skunkwerks design team created a new modulation scheme to resolve the caper's JT-65 Rebel technical challenge (Figure 2).

Concerning this fine friend, I will simply state that not even a speck of dust has time to settle on this man of perpetual motion. He is hyperactive in the Maker and ham radio communities alike.

Perhaps you had a chance to see Glen's "tricked-out" Rebel Transceivers at FDIM and at TEN-TEC's Dayton Hamfest booth.

And, I would highly recommend that you look for Glen's new book, *Arduino for Ham Radio*. (It should become available from the ARRL by the time you read this.)

In the spirit of the Peter Gunn, 1950s television series, and Henry Mancini's infamous Peter Gunn theme song, I played the detective role. My job was to sleuth-out how everyone can create such QRP amateur radio adventures for themselves (Figure 3).

(NOTE: I have received feedback indicating that most forum attendees found something of interest in our adventure-sharing presentation. However, evidence also indicates that all who attended did not particularly appreciate my sleuthing around with the illuminated magnifying glass.)

Videos for all of the actual FDIM 2014 forum presentations are at:

http://www.ustream.tv/recorded/47599691

All of the "Solder Smoke #160" impromptu audio Interviews with the forum presenters can be found at:

http://soldersmoke.com/soldersmoke160.mp3

Next, I thought I should share a com-

Figure 1—WØERI, accomplished actress and renowned adventuress.

Figure 2—KW5GP, notorious and shifty Skunk-at-Large.

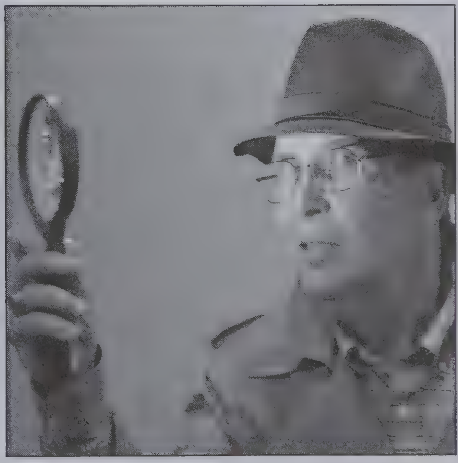


Figure 3—Detective NM4T honors Peter Gunn and Henry Mancini.

Figure 4—KB5EZ, WA2JQZ and NM4T become The Tres Amigos. (OK, so these amigos are Chevy, Steve and Martin — not Rob, Gary and Craig).

ment I received in response to my Spring *QQ* column concerning "Go Bags":

"In the very early days of SOTA, to my horror, very little attention was paid to safety in the hills, and as a result an amateur in the UK died in the hills descending from a SOTA location. I would not want this to happen to the much younger amateurs who are attracted to the hills/mountains.

Best wishes, Mark Raybould, G3XYS/NS1Q"

To Mark's comment, there is always an element of risk when one sets off on adventures. Please be safe and be sure to include safety as part of your mentoring activities with others.

Shifting gears, I know (firsthand) that many of you participated in Paul Harden, NA5N's, combined QRPTTF and SOTA Tres de Mayo contest event. Being a creative and fun-loving kind of guy myself—I love what you do for the gang with these special events, Paul—Thanks, Amigo!

QRPTTF contest details and results can be viewed at: www.zianet.com/qrp/qrpttf/2014/ttf.htm

Here's a summary of how Rob Suggs, KB5EZ, Gary Agranat, WA2JQZ, and NM4T participated in "Tres de Mayo" as "Tres Amigos" doing a RaDAR operation at "Tres Locations." (The "real" amigos are in Figure 4.)

A trailer with credits for this movie can be viewed on YouTube at: www.youtube.com/watch?v=WUTl8DSYUQA

Our Tres de Mayo began early so we could check out a couple North Alabama summit sites that have not yet been SOTA (Summit on the Air) activated.

To our chagrin, High Top, W4A/HR-001, had a collage of "No Trespassing" signs on the road at the bottom of the mountain and Johnson Top, W4A/CP-002, looked like we would have to pass through someone's back yard. Both were non-starters for us, but we established that more research and getting permission will be required before we attempt these again. (We posted our findings on the SOTA site to inform others who might be interested.)

Serpentine roads eventually brought us back to civilization. However, we decided to stop first at a quaint country gas station and mini-market. It was (officially) time for us to reach a consensus on our Plan B. (One must ALWAYS have a Plan B!)

So… With a modicum of animated collaboration, we settled on a transportation-themed QRPTTF that would also incorporate RaDAR (Rapid Deployment Amateur Radio) operational techniques. We would try to operate at the Tennessee Valley Railroad Museum for trains, followed by the Moontown Airport for airplanes, and finally at Ditto's Landing Marina for boats, next to the Tennessee River (Figures 5-7).

We started with KB5EZ making one TEN-TEC Rebel-based JT65 contact on 20m with my KX3 and AlexLoop. Then, we switched our 5-watt operation to straight key CW, each making 4 or 5 (multi-band) contacts at each site. This turned out to be a mix of QRPTTF, SOTA stations and a few QSO party stations.

Although Gary has become an accomplished CW operator, Rob hadn't touched a straight key for about 30 years (and he claims that he was never good with one even then), but we all managed to get the job done. It was now time to head home… But we were having so much fun that we made a couple more 40m contacts on the AlexLoop before wrapping—up, just for grins!

This was Rob and Gary's first opportunity to use the KX3 and AlexLoop. Rob later reported, "The KX3 is one sweet rig and the AlexLoop works amazingly well. It sets up instantly and is easy to tune by ear. We had EndFedz and Hamsticks in his SUV, but things were a lot simpler with the loop."

As a side note, we were (likely) the only QRPTTF team who had to deal with local QRM from train whistles, taxiing aircraft, and powerboats. The sailplanes landing were not a source of noise, but they did

Figure 5—Railroad Museum (34º 47' 01.3", 86º 32' 49.8", 834 feet elev.).

Figure 6—Moontown Airport (34º 44' 48.13", 86º 27' 38.53", 647 feet elev.).

Figure 7—Ditto Landing (34º 34' 26.8", 86º 33' 38.3", 575 feet elev.).

Figure 8—Using an AlexLoop at Moontown Airport.

distract our operation for a few minutes each time we watched. The weather was outstanding, the fellowship was great, and we all want to do it again. Life is good!

Now, let's get back to antennas. Since we only used my AlexLoop antenna (Figure 8) in our Tres de Mayo adventures-I'll share some anecdotal comments.

As with all antennas, the AlexLoop performs best when kept away from metal structures as much as practical. Further, this also facilitates antenna pointing and tuning, since the antenna's propagation patterns are more predictable. Mounting the AlexLoop on an insulated antenna support vs. using a metal stand that goes up the PVC base placing metal near the tuning box. (In our outing, we moved our antenna to get it away from the metal awning above our picnic table. We had one person tune the antenna while the operator gave hand signals to tune up, down or stop.)

Ground effects take a bigger toll on the performance (efficiency) when such compromise antennas are used on the lower bands. Elevating the antenna appears to improve its performance slightly for 30 and 40-meters.

For those that already have AlexLoop antennas—here are couple ideas to check out: The narrow tuning range, typical of magnetic loop antennas could be a problem if/when you need to operate split, such as on DXpeditions. I've not invested time to see if there is a good way to work around this.

And, it might be worthwhile to modify the AlexLoop's coax input to include a TEN-TEC Transmatch Antenna Tuning board to facilitate tuning it by ear in the field. (I now have one that I'll build-up, so expect a report for how this works out in my next column.)

http://www.tentec.com/categories/Kits/?sort=featured&page=2

This said, the AlexLoop is a remarkable, compact, easy-up antenna really does a very credible job for its size and portability.

And, here's an overlooked bonus we discovered—the AlexLoop is (generally) at home in environments involving non-hams—nobody seemed to be intimidated by it! In fact, it seems to make some people curious, often drawing people over to see what we're up to. Compare this with hanging wires in trees and/or rising vertical antennas in busy locations.

(In fact, on one occasion, while operating with an AlexLoop at a Monte Sano overlook, three teenage girls came over to ask if we were looking for Sasquatch!)

Looking forward, I hope to see you at the ARRL Centennial Convention. Be sure to visit QRP ARCI's booth and to attend Ken, W4DU's invitational QRP presentation and the presentation that Glen, and I are making: When Worlds Collide: The Blending of the Maker and Amateur Radio Cultures.

And… This year's Huntsville Hamfest and Two Days in Huntsville (TDiH) events will be awesome! As one of the six ARRL Centennial Hamfests, unique activities will include a competition grade W100AW/4 radio operation (just outside the Von Braun Civic Center) as well as 4 QRP-centric forums given by celebrity presenters.

Plan to join us up on Monte Sano for our traditional Southern BBQ and the novel TDiH QRP events we conduct. This time, we already have seven rustic cabins (and additional camping sites) reserved to support attendees and to house the QRP "movers & shakers" who help me make this major QRP enterprise happen.

BuddiPole fans and Buddies in the Caribbean (BIC) Suitcase DXpedition "hopefuls" will be delighted to know that Chris, W6HPF (and other BIC DXpedition participants) will be joining us for the first time. They will have a BuddiPole booth at the Hamfest and will be staying in the rustic cabins.

Our Quarterly Challenge: Since we'll continue our discussions about optimizing portable antennas in the Fall *QQ*, it would be great if you would take a more critical look at the portable antennas you are currently using. Let's gain a better understanding concerning how effective they "actually" are and what we can do to apply field antennas more optimally.

Please be sure to share your findings with me via email.

I intend to share my findings from a couple gain antenna system designs that I am experimenting with that could serve you well in your field operation activities.

Finally, thanks again for all you contribute to amateur radio and for joining me in stirring up copious amounts of mischief…

All in the name of QRP, of course ;-)

—Craig, NM4T
"The Huntsville QRP Guy"

QRP Clubhouse

Timothy Stabler—WB9NLZ tastabler@comcast.net

Well here I am again for about the fourth time in four days. I had this column done and saved (I thought) but when I shut the computer off, everything (and I mean everything) was lost. So I am starting again, but this time I have a flash drive ready to go. Both of my computers needed work—which I had done. My Yahoo address sends most everything to "trash" so I also changed my email address for that reason (note it above).

Figure 1—ECI-QRP meeting photo. Bill, W9VC is talking to the group.

East Central Indiana QRP Group

This is a group I like to get to each meeting of. Last October, when I arrived at the Maring Hunt Library in Muncie, I noticed people standing in the parking lot. I did wonder why nobody had gone in and then found out the library had decided to close on Saturdays. Donnie Garrett, WA9TGT, had set up our meeting dates and time about a year earlier but had never heard a word from them about the closing. So we got in our cars and followed Donny to his house and had our meeting in his garage. It was an interesting meeting. In the next week, Donny "talked" to the people at the library. This year, we have our meetings set for Saturdays at noon at the Maring Hunt Library.

To go to the April meeting, I left about 7:30 AM as I am in the Central Time Zone. Muncie is in the Eastern Time Zone and it takes me about three hours to drive there. Just outside of Muncie, my phone rang. It was my daughter telling me my Infinity alarm system had gone off and that cops were at my house. I immediately turned around and headed home. The bottom line is my dog had set off the motion detector. At my former home, the motion detectors were off with the alarm code we put in. With Infinity, the motion detectors have to be turned off separately when the code is put in. Yes, I learned something.

Since I did not make the meeting, Donnie took some notes and sent them to me for inclusion here:

The ECI-QRP (East Central Indiana-QRP Group) met April 12th on a beautiful spring day with 10 members in attendance. The meeting was held at the usual meeting place, the "Maring Hunt Library" meeting room in Muncie, IN

This meetings presentation was given by Bill Murray, W9VC who did a presentation called "QRP Operation in Northern Michigan".

Bill began his presentation by showing us some of the QRP radio gear he has used over the years during his many camping trips up into Northern Michigan (Figure 1). The gear included such rigs as his little Small Wonders SW-40, Index Labs "Cube" and his Elecraft K1 just to name a few.

Also discussed were the types of antennas he used and portable power sources used to power his radios. Bill's presentation made for a really nice first half of the meeting.

The last half of the meeting was as our "Round Table" half of which each attendee discussed what they had been doing over the past few months.

A first time meeting attendee, Steve W9SN did a nice demonstration of a solar panel and power charging system and explained how it could be used to help provide power to operate radios when no other power sources were available.

CRES-ARC (Columbus, Ohio) QRP SIG QRPTTF 2014 Event

At FDIM, I ran into Steven Katz, N8WL. We talked about clubs and he promised me some notes on his group. This is what he sent. If you look at their website, you will see how their name came to be.

Members of the CRES-ARC QRP Special Interest Group (www.w8zpf.org) had a fun time in last year's QRP To The Field event operating from Scioto Trail State Park, in southern Ohio. We were intrigued by the Mexican theme announced by the QRPTTF organizers for this year, and we were excited about how it might play out. On Saturday morning, May 3, 2014, five of us gathered at the campground shelter of Great Seal State Park near Chillicothe, Ohio, about 50 miles south of Columbus (Figure 2). Dave K8AX, Fred WA8PGE, Connie WD8ODC, and Steve N8WL had been here last September for the Ohio State Parks On The Air (OSPOTA) event. Joining us for the first time was Brad, AK8H of Lancaster, Ohio, an avid contester and, since acquiring his Elecraft KX3 a couple of months ago, an avid QRPer as well.

Great Seal State Park is on a hill (at least by Ohio standards) and thus has a

Figure 2—Great Seal State Park (Ohio) entrance sign.

Figure 3—The shelter at the campground where we operated. The antenna mast is to the left of it.

Figure 4—Fan dipole for 40-20-15-10 meters. The mast to the left is holding up a 10M leg.

great advantage for QRP operation. It's like having an antenna several hundred feet high above the surrounding terrain. That's why we did so well in OSPOTA last year (we won a first place plaque in the low power multi-op category). We were hoping to use the site to our advantage again for QRPTTF and we were not disappointed.

The weather that morning was overcast and windy. We set up Brad's portable military mast and at about 36 feet we hoisted Fred's three-leg fan dipole with legs cut for 40-20-10 meters (and the 40 meter leg resonates on 15 as well). We used trees to tie off all the legs except one, where there was no convenient tree, so we lashed a 33' extension pole to a picnic table and ran the last leg to it. As a back-up antenna, and to experiment with, Fred brought his homebrew magnetic loop antenna which resonated on 20 and 15. Fred worked a few stations in the 6th and 7th call areas on CW at 5 watts with this loop, but we didn't count them for the event. He also brought a Hendricks Tribander QRP kit that he built last winter as a back-up rig.

Figure 5—Fred WA8PGE at his CW keyboard making a QSO on 15M.

We used Brad's new KX3 for the entire day, and it never failed us. We used our club call sign W8ZPF, and worked mostly SSB this year, with a little bit of CW, which is just the opposite of how it went last year. We heard very few QRPTTF stations on the air, no SOTA stations at all, and if it hadn't been for the very lively Indiana, 7th call area, and New England QSO parties, our score would have been close to zero. Thankfully there were a lot of stations to work and we kept very busy. We did about as much searching and pouncing as we did running a frequency and calling CQ. We all took turns logging and operating the rig. The KX3's digital voice recorder came in handy for SSB, and Fred's memory keyboard worked great for CW.

Figure 6—Fred WA8PGE with his homebrew magnetic loop antenna which we used for a back-up. He did make several QSOs with it and it worked very well.

As far as the Mexican theme, we had a hilarious time with it. Everyone brought various brands of tortilla chips, salsa, guacamole, and other Mexican snacks. Steve brought some burritos from a Mexican restaurant. Connie brought some little plastic sombrero party hats (see Figure 7), and Brad brought a pinata filled with chocolate candies.

It got very windy during the late morning, so we lashed two tarps to the corner of the shelter to give us some protection from the cold breezes. By late afternoon the sun came out and the winds died down a little bit. When the contest was all over, about 8 pm, we had worked 110 SSB stations and 30 CW stations. We scored at the very top in fun and can't wait to do it again next year!

After the last QSO, we tore down the station, packed up the antenna and masts, and had a champagne toast (with sparkling grape juice as we had to drive home) to celebrate our victory! We look forward to our next QRP outing, which will be the Ohio QSO Party!

Ozarkcon 2014

In April, I made my annual trip to Ozarkcon, sponsored by the 4 State QRP Group (4SQRP). As I remember, I have made each meeting except for the first one. It used to be held in Joplin, but when the

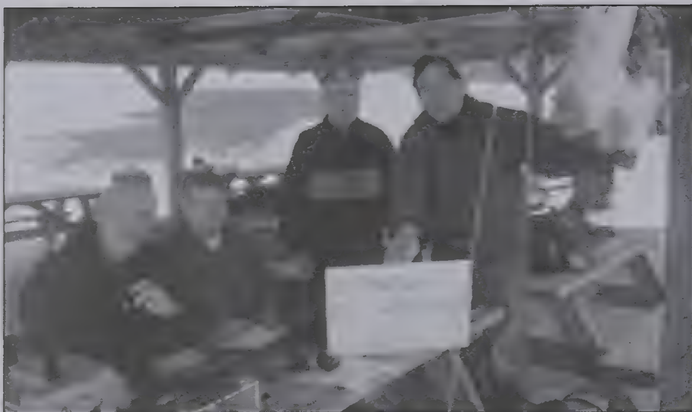


Figure 7—From left to right, Brad AK8H, Fred WA8PGE, Dave K8AX, and Steve N8WL. Notice the sombrero party hats and the pinata! Not shown is Connie WD8ODC, the photographer.

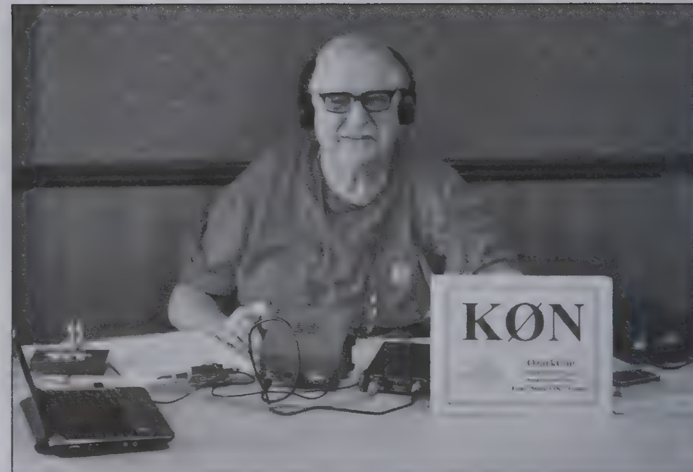


Figure 8—Burt Lawson, WØIIT, with the Dummy load station.

hotel got sold, the meeting was moved to Branson. This hotel, the Stone Castle Hotel & Conference Center, is a very nice place to hold the meeting. They allow attendees to book up to 7 additional nights at the meeting rate. They like having the meeting there and have booked the meeting in through 2020. If you want to go in 2015, registration will probably be on line (www.ozarkcon.com) by February.

As usual, I got there Thursday afternoon to give me Friday morning to look around town. One stop I made Friday morning was the Branson Craft Mall to get some fudge. The lady told me they were catering something at the hotel on Saturday but did not mention what. You will see what later.

Registration began at 4 PM and this also was the time for Burt Lawson, WØIIT, to start up the dummy load QSO party (Figure 8) and for the vendors to their open their Swap shop. Before dinner, Ross Summers, President and CEO of the Chamber of Commerce (Figure 9), talked with the group. He welcomed everybody to Branson and apologized that he had to leave early. He talked of the number of people living in Branson and the huge numbers of visitors each year. Then he talked of the tornado that hit the town the year before that went down M-76, the main road through town. There had been a huge amount of damage but no lives were lost. Many places that were damaged were now back in business. Then dinner was served.

At 7 PM, there was a buildathon, (Figure 10) which this year featured a regenerative receiver, the Ozark Patrol (Figure 11). The 4SQRP group sold them out at FDIM, but are expecting the parts to come in for future kits. This is a two band receiver where the parts are mounted on the board, not through the board. There are no surface mount parts. If you want to see the board, go to www.4sqrp.com and look at the kits offered. When you bring up the "kits offered", the Ozark Patrol is the first kit and if you go to that kit, a picture of the board is offered there. It was an interesting build.

On Saturday, the morning opened with comments from Terry Fletcher, WAØITP (Figure 12). He told us that there were 130 attendees at the opening, which was the record for attendance. This was the 12th Ozarkcon and the 7th at Stone Castle. He also announced that lunch would be served for everybody. This was a first for Ozarkcon. He also announced that Phil Anderson, WØXI, would be the Master of Ceremonies for the meeting.

Phil took over and announced the first talk "The RBN and more—a year hamming in Iraq de N4EO, ex-YI9EO" by Jerry Brown, N4EO (Figure 13). Jerry had

Figure 9—Ross Summers talks to the gathering.

Figure 10—Buildathon in progress.

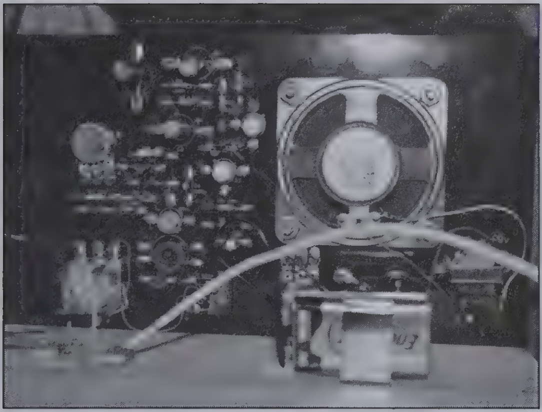


Figure 11—Finished regenerative receiver from the Buildathon.

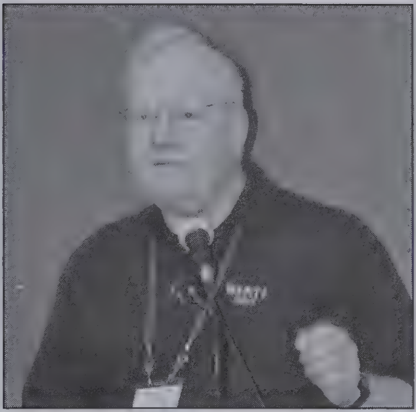


Figure 12—Terry Fletcher, WAØITP, welcomes everyone to Ozarkcon.

Figure 13—Jerry Brown, NE4O, giving his talk on Iraq.

spent 8 months in Iraq as YI9EO in Sulaymaniyah. He was there originally in Erbil, a city in the Kurdish region for a clinic starting PET/CT scanning. He has got to know students and has gotten them interested in ham radio. He talked about the number of contacts he had made using the reverse beacon. I apologize to you and Jerry for not having more here but the lights were shut off to see the screen and I was unprepared.

The second talk was "Being QRP DX from Caribbean Islands by Craig Behrens, NM4T (Figure 14). Craig had gone to St Lucia by plane and then traveled north to be near the sea. He was accompanied by Rob Suggs, KB5EZ, Glen Popiel, KW5GP, and Joe Large, W6CQZ. They called themselves "The Skunk Werks". The St. Lucia club members were really big helps in getting set up with the antennas, etc. He pointed out that "licenses" are different for each island and that customs were interesting in both getting in and out.

They had set up some Buddipole antennas as the company does host several DXpeditions each year. Craig had taken his Rebel (TEN-TEN 505), for JT-65 use (the source coded for this is available). He had programmed the Rebel for this type operation. He also used a 17 M beam, which is not yet in production. He then told us that getting a license was very tough and it helped to have an insider help you.

The third talk was "Making the EZkeyer" by Craig Johnson, AAØZZ (Figure 15). His keyer came from his interest in the PIC-EL from the New Jersey Cub. In the third generation of this board, a USB port was added, so it started looking like a keyer. Steven Elliott, K1EL, had published code for his keyer, so Craig adapted it for the PIC-EL. Terry Fletcher, WAØITP, asked about a keyer for Ozarkcon and Craig said he would do it.

He started off with the 16F628A processor, but then changed to the 648, as it could do longer messages. In his third version, a speed pot and voltage regulator were added. Thius has become a very good kit for the 4SQRP Group.

Lunch was then served. Remember my fudge? The counter that had the fudge also ran a deli. Terry had ordered the sandwiches from there; I got a ham and cheese. I think chicken salad and something else were also available, depending where you went at the counter for your sandwich. When you opened the sandwich, there was a bag of chips and below the sandwich, wrapped in a napkin, were things to put on the sandwich and a wedge of pickle. Also included was a small helping of fudge. Bottles of water were also available.

After the lunch break, the talks resumed. The first talk of the afternoon was "Understanding Mixers" by Phil Anderson, WØXI (Figure 16). He wanted to look at mixers without math. He pointed out that the sine wave is a unique wave form. You can add two waveforms and other waveforms cannot do this. If you add two waveforms of different frequencies, they will double in size if in phase and if 180 degrees out of phase, will cancel each

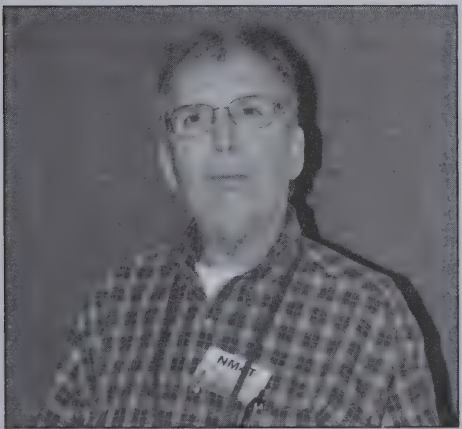


Figure 14—Craig Behrens, NM4T, describes QRP operation from St. Lucia.

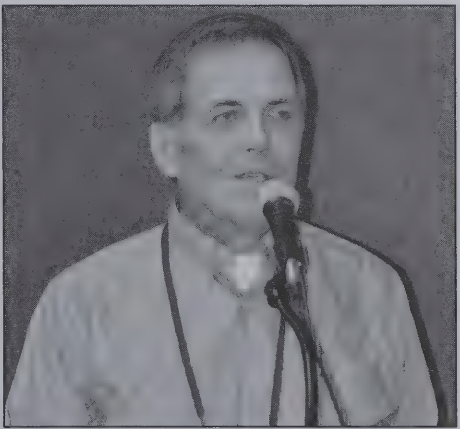


Figure 15—Craig Johnson, AAØZZ discusses the EZKeyer.

Figure 16—Phil Anderson, WØXI talks about mixers.

Figure 17—The winning Wacky Key, a kitchen scale key, and its creator.

other out. He asked which mixers approach doing a pure multiply? A JFET will multiply RF. A mixer can shift the frequency. You cannot overdrive a mixer. He uses LT Spice for his graphs of mixer functions.

The next talk was "Poor Hams Scalar Network Analyzer" by Jerry Haywood, W5JH, Jim Giammanco, N5IB, and Nick Kennedy, WA5BDU. Jim started off by telling us what he wanted to get—a sweep analyzer, a signal generator and a RF detector. Jerry looked at the applications and what sorts of measurements could be made including gain loss, and bandwidth. Nick pointed out that the project was originally called SSNAFFHU, for Simple Scalar Network Analyzer for Hams-Unveiled but was standardized on PHSNA for Poor Hams Scalar Network Analyzer emphasizing the low cost of construction. The system is built around off the shelf modules including an Arduino. Nick has a good write up of the system in the Spring issue of this magazine.

I apologize right here as my camera decided to totally freeze and I was unable to get pictures of the final 4 speakers. A camera man told me these new cameras are like computers and do what they decide to do whenever. I also had a freeze at FDIM. Next time I will have a a second camera with me.

The last talk was "Portable Operating" by Max McCoy, KCØMAX. Max wanted to operate portable at several different locations, including following the Arkansas river from its headwaters to the Mississippi. He started at the headwaters and got to Canyon City. Some of his material has appeared in *QST*. At the headwaters, he had to find a place deep enough to put his kayak in. He tried to do about 20 miles each day. He used his Icom 703 and his PAC-12 antenna. At night, he would operate PSK-31. Altitude and fatigue were problems. He went over problems that one get into if on the trail someplace. Emphasis was on safety. The more remote you are, the more the cost of your resources. But he wound up with we got into this hobby for fun and don't let the fear of failure stop you from trying.

After the talks, the final door prizes were drawn. I even got the Four State NS-40 transmitter which now sits in my "to do" pile. The Wacky Key contest went to the originator of the Kitchen Scale key (Figure 17). I apologize as I did not get the name and nobody at 4SQRP could give it to me. They did give me the winner of Best of Show which was Gary Auchard, WØMNA (Figure 18), who I think had built a 40M transceiver. The pictures of these two are from "The Banner", published by 4SQRP. I thank them for allowing me to use them.

Lastly, there was an award given to Terry Fletcher, WAØITP. It was the Lifetime Achievement Award.

That was the end of the meeting and I am sure everybody who attended, including myself, are getting ready for Ozarkcon, 2015.

Michigan QRP Club

At FDIM, on Club night, I happened to run into Rich Fowler, K8MEG. He mentioned the Michigan Club were going to have their annual picnic so here is his input.

The 2014 Michigan QRP Club picnic will be held on September 6, 2014 at the Bear Creek Nature Park, 740 W. Snell Road, Rochester, MI 48306. Google for detailed information about the trails and observation locations. Picnic and antenna setup start about 10 a.m. Lunch at noon.

Attenders are encouraged to bring show 'n tell, swap items, and QRP stations. There are tables in the pavilion to set up a station, but it may serve as a food table as well. Bringing your own operating table will give you more flexibility. WQ8RP is the events call sign. Individuals may use their own call. For questions, please contact Ed Kwik, AB8DF,

Wrap-Up

I guess that is all I have for right now. Be sure to send me your club news. In looking over past issues, there are several clubs who used to send stuff in but I have not heard from for months. Without your input, there is no column. And many people have told me how they read this publication from cover to cover more than once.

—72, Tim, WB9NLZ

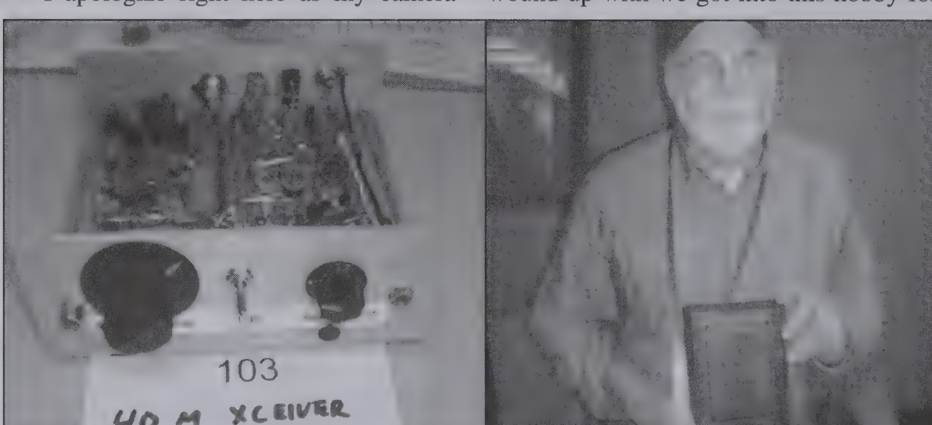


Figure 18—A 40 M transceiver (left) and its builder, Gary Aucherd, WØMNA, who got the Best of Show prize.

Many Ways to Homebrew

Harold Smith—KE6TI harold.smith1@gmail.com

This article is KE6TI's presentation at FDIM 2014. As a good review of homebrew construction methods, we thought it should be published for all QQ *subscribers to read! —Ed.*

Construction Techniques for Radio Builders

I got into ham radio, and into building radios, in my Freshman year in high school. My General Science teacher was a ham, and he used radio as the way to get us interested in science. But he taught more than the science—he also spent a few minutes a day teaching us Morse Code.

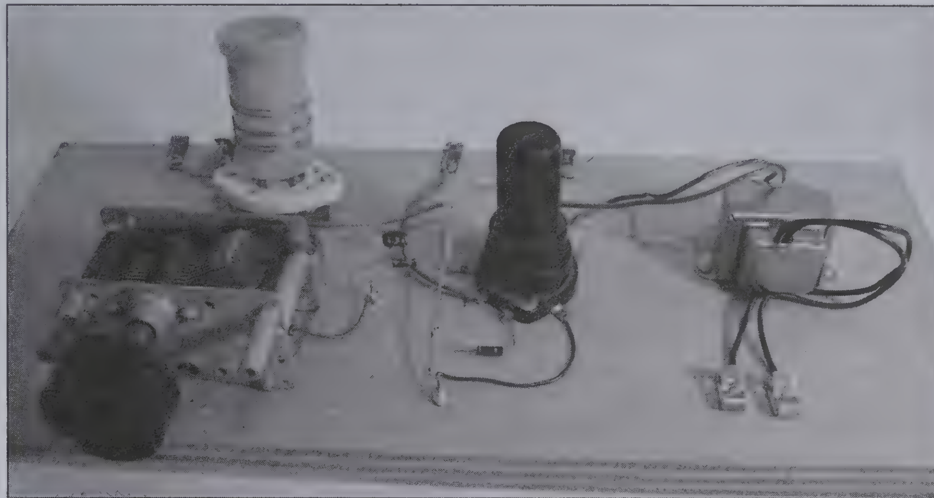
I vividly remember the day he explained the fairly simple principle behind the vacuum tube's operation. My reaction was 'Cool!' And then 'I want to do that!' I immediately started trying to build a radio. It took me a while, and many tries, but I did build a radio that worked, and then another, and another. As of today, there are no radios in my shack that are not homebrewed.

Radios have evolved since then, and the techniques used to build them have, too. This presentation is about how to build a radio, and specifically how to build a homebrew radio. I define a homebrew radio, for the purpose of this presentation, as any radio or radio-related electronics that is built without a pre-defined set of instructions. That is, I am not including kits, though it need not be something designed by the builder. Not everyone will have the know-how to design a radio, but anyone with a modicum of manual dexterity and the ability to read a schematic and recognize electronic components can build.

I will not talk about what to build, or where to get the schematic, or the parts. This presentation assumes all that is ready, and it is time to start actually building.

Breadboard Construction

Way back in the dark ages, when vacuum tubes ruled the Earth, the first method of building that came to be commonly used was called Breadboarding, because it involved the actual use of a cutting board liberated from the kitchen. Tube sockets, etc., were screwed to it, and brass nails were used as tie points for the wiring. The term 'breadboarding' has survived to the present day, but the cutting board and the tube sockets, mostly, have not.



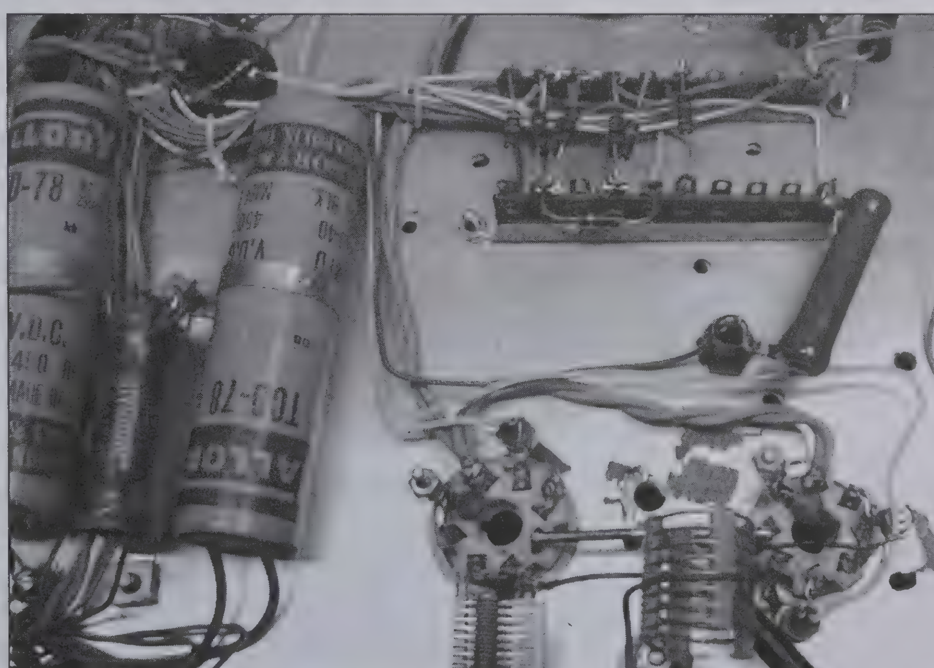
Breadboard construction.

Chassis and Terminal Strip Construction

The next technique to come along was the chassis and terminal strip method. This was the classic way most tube equipment was built, and much tube-based audiophile equipment is still built this way. Aluminum is most commonly used for the chassis, since it is fairly easy to work. Terminal strips are still manufactured, though they don't seem to be commonly stocked by electronic supply houses.

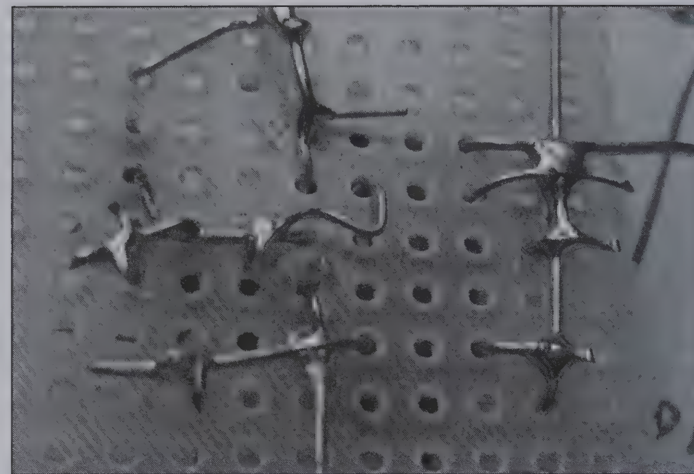
Printed Circuit Boards

I'm going to skip quickly over printed circuit boards, (PCBs) also, and more correctly, called printed wiring boards. There are enough variations on the layout and making of PCBs that they could make an entire presentation by themselves. Of all



Chassis construction.

Perfboard construction—top side.



Perfboard construction—bottom side.

the methods I'll describe today, PCBs are the most applicable to reproduction. That is, if the circuit is going to be duplicated often, by yourself or by others (as, for instance, a kit to raise money for a club) consider a PCB. If there will be only one or two copies, other techniques will probably be easier, quicker and often less expensive. PC boards are almost mandatory if building a circuit entirely of surface mount components. And PC boards are necessary for many distributed circuitry techniques, which are usually not encountered below the high VHF range.

A variation on the PC Board championed by noted homebrewer K7QO is what he calls Muppet construction. It consists of a pattern etched onto a PC board, but with no holes. Instead all the parts are mounted on the copper side. This saves all that drilling, and allows a mixture of through-hole and surface mount components to be used. Since the circuitry is all on one side, the board can be mounted flat to the bottom of an enclosure. It is also easier to troubleshoot than circuitry that is on two sides.

Solderless Breadboard Socket Construction

The next technique involves the use of a breadboard socket,also called a solderless breadboard. These are rows of sockets into which parts are plugged by their leads, with the socket contacts providing the interconnections. These are very easy to use, with the caveat that one must use only the right sized leads to avoid damaging the contacts.

They are, however, not usually very useful for RF service, due to relatively large parasitic capacitances. They are also not permanent, since the parts are held only by friction.

Perfboard Construction

A much more important technique available to the homebrewer is based on a material generically called perfboard. Perf board is a sheet of insulating material with patterns of holes punched in it. It might or might not be clad with copper on one or both sides, and the copper might be etched into any of several potentially useful patterns. There are also available terminals that can be pushed into the holes to make attaching components easier.

In any case, perfboard is usually used by putting the components on one side, and putting the leads through the holes or soldering them to terminals inserted into the holes. The interconnections are then made on the other side, using either the excess lead length of the components, lengths of hookup wire, or the copper patterns, if any.

Solderless breadboard construction.

Perfboards are available with several different patterns of copper traces. Some are designed to make building with DIP ICs convenient, others are optimized for discrete transistor circuitry. Perf board is fairly easy to use. For RF circuitry the lack of a ground plane can sometimes be a problem. Copper tape can help.

Building on perfboard is fairly easy and fairly quick. If the type with copper pads is used, parts are simply soldered to the copper pads. If the type with an overall copper clad side is used, a drill bit, slightly larger than the hole diameter, can be used to remove copper from around the hole. This need not be done if the lead is to be grounded to the copper plane. Perfboard with solid copper on one side can also be etched to make printed circuit boards, and the holes can save a lot of drilling.

The biggest downside of perf board is that the stuff is expensive, especially the types with special copper patterns.

I find perfboard most useful for smaller circuits, where the lack of a ground plane is not an issue, and where it is easy to keep track of the relationship between the circuitry on top and on the bottom.

Island or Manhattan Construction

Another popular method of building is called Island or Manhattan style. In Manhattan construction, a conductive base plate, usually a piece of copper-clad PC board stock, is used. The insulated islands, or pads, for the non-grounded components are made by punching or cutting small pieces of PC board stock and gluing them

to the base. Component leads that are to be grounded are soldered directly to the base. Manhattan construction can produce very good-looking circuitry, without the hassles of making a PC board. It is also easy to troubleshoot, and, depending on the tenacity of the glue used on the pads, easy to modify.

Pre-made Manhattan pads, both singles and pads for transistors and ICs, including surface mount styles, are available from vendors who service the homebrewer.

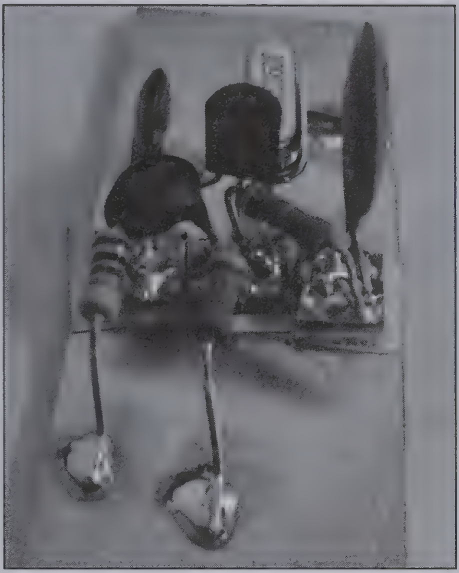
A variation on Island Construction involves the use of what is called a pad cutter. This is a tool that will carve a circle into the copper of a piece of PC stock, leaving an insulating ring around it. The pad thus produced can be used like a Manhattan pad, but, of course, can't be moved. Tools to make these are somewhat hard to find. There are two types: one uses a drill bit or centering pin, and can be used by hand; the other does not, and should only be used in a drill press. The former type will leave a hole in the middle of the pad, which may or may not be a bad thing. Pad cutters can also come in handy if one discovers that he has left out a trace when making a printed board.

Ugly, a.k.a. Dead Bug Construction

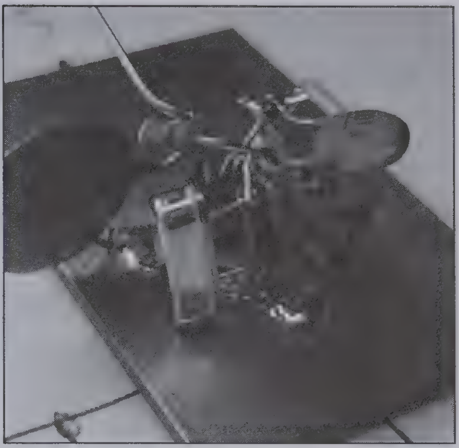
The final building technique I will discuss is called Ugly or Dead Bug Construction. Ugly construction involves a conductive, solderable base plate, as in Manhattan construction, but there are no pads used. Instead, any circuit nodes that are not to be grounded are simply up in the air above the base. Parts are held to the base by any grounded leads, and parts that have no grounded leads are suspended by the leads of those that do. The term 'dead bug' comes from its use of ICs mounted upside down, with their leads sticking up like the legs of a dead insect.

Ugly construction is my preferred method of building, because it is quick, the continuous ground plane makes for good RF performance, and it is fairly easy to modify. It is entirely unsuited to mass production, but I have never built more than one of any of my radios.

Ugly construction on double-sided board can be built on both sides. (This can also apply to Manhattan.) The circuits on the two sides are shielded from each other by the solid ground plane. Mounting will be complicated a bit, but not overly so.



Island or Manhattan construction.



Ugly or Dead Bug construction.

Construction Techniques, Enclosures and Shop Practices

Unless you are going to build only on a solderless breadboard, you will need to know how to solder. Heat the joint, not the solder. A good solder joint is shiny, and has flowed. Practice helps. Of course, always use rosin core solder, NEVER acid core. Acid core solder is for plumbing, not electronics.

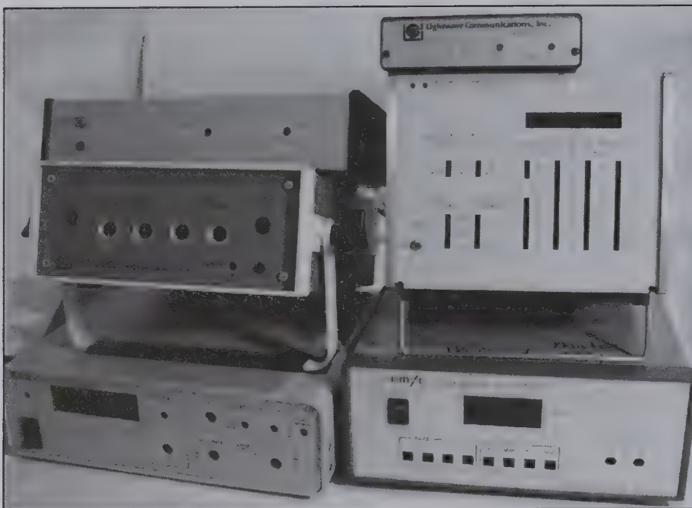
Whether you use a simple iron or a temperature-controlled soldering station does not matter much, though either way a grounded tip helps protect against static. Keep the tip tinned for longest life. If the iron has a screw-on tip, it will help if you put a tiny bit of heatsink grease on the threads before you put the iron in service. This will make it easier to change the tip when it wears out.

It also helps to work on an anti-static surface, to protect your parts. A 16 by 24 inch anti-static mat, which is big enough for most projects, can be bought for under twenty dollars, and is cheap insurance for your sensitive electronic components.

Once you have a working circuit, built up using your choice of method, there are still a few things to be done before you have a finished radio, or whatever it will be. It should be enclosed in some sort of cabinet, to protect it from handling, and so it looks appropriate in your ham shack. It probably needs power, and may need some sort of control calibration, so you can operate it and have some idea what's happening.

It is possible to make your own enclosures, using aluminum, brass or steel sheet or unetched printed circuit stock.

A variety of tins can be used as enclosures.



Commercial enclusures ready to be re-used.

Extra holes can be covered by front panel labels.

Enclosure made of PC stock can be soldered together to make an RF-tight enclosure, but doing so requires precision cutting of the material. Homebrewers who do so usually use a shear, rather than trying to get straight cuts with a saw.

There are also lots of commercially made enclosure available, in almost any size desired. New ones are expensive, even relatively small ones, and the nicer they are the more expensive. Small projects can be housed in cans such as the ubiquitous Altoids tins, which are also useful for internal shielding of subassemblies within a larger cabinet. Craft stores sell holiday-decorated tins for cookies or whatever, and after the holidays these are often discounted steeply.

I usually prefer to use recycled cabinets. The medical, industrial and computer industries have generated myriad instruments and accessories through the years, many of which turn up in flea markets when they become surplus to their original owners. Tomorrow starts one of the best of those flea markets, and hunting for obsolete instruments to recycle into radios is one of the main reasons I will be there.

Recycling obsolete electronics can have other benefits besides a reusable cabinet. There are often useful parts inside, and sometimes controls and knobs on the panels. When negotiating prices with sellers of such electronics, it often helps to let them know you are looking at that instrument only as a potential enclosure.

Equipment that has become excess has often been poorly used and stored and will usually be at least dirty. Cabinets can be cleaned by hand or by running the parts through the dishwasher. Be careful of plastic parts in the dishwasher, though. Once cleaned, the cabinets can be painted to hide scratches, stains or marks, or simply to get them to match your other equipment.

Whatever cabinet you choose to put your project into, make sure it is big enough. Remember that it not only has to hold the electronics, however many modules that might be, but also has to accommodate connectors and controls. And it often happens that a homebrewer might want to add features later on, such as a keyer, a frequency counter, an SWR bridge, or whatever. Unless you are planning to make a backpack radio, there is no great advantage to using the smallest possible package.

It helps, in fact, if you know before you start building what enclosure you will use. This makes it easier to size the electronic subassemblies, and gives you a good idea of what sizes of controls you can use. A three inch tuning knob might not play well with a two inch high cabinet.

Before you start mounting everything in the box, spend a little time considering the ergonomics. Do you prefer the volume control on the right or the left? How about the key jack? Will the cord be in your way on the operating desk? A little time spent pondering can save a lot of time being annoyed.

Recycled equipment cabinets can have problems other enclosure choices do not, such as too many holes in the panels, and holes in the wrong places. Sometimes the easiest thing to do is replace the panel completely. There are stores online that sell small quantities of sheet aluminum cut to size, for not too much money. Plastic can be used if shielding is not important.

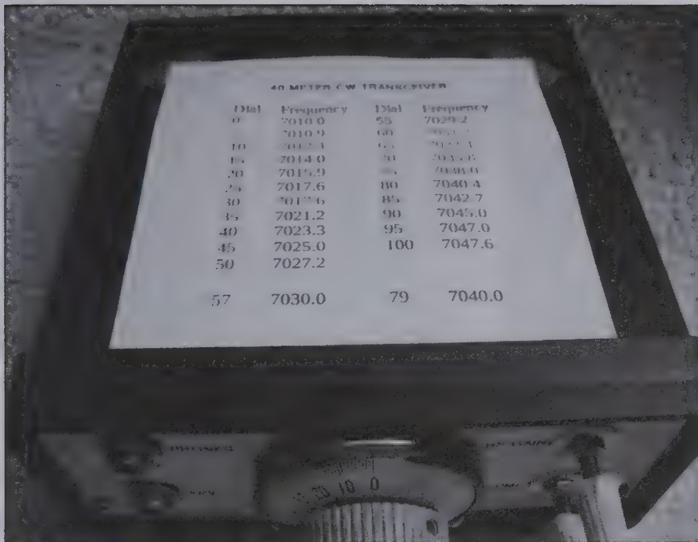
Alternatively, it is possible to cover the holes, if they can be worked around. Paper or plastic will often do, unless complete RF shielding is a requirement. Avery makes ink jet-compatible shipping labels with a foil-like inner layer that does an excellent job of hiding what is underneath.

When you need holes that aren't already there, a drill obviously makes nice round ones. For larger holes, or for non-circular holes, a nibbling tool is a great help.

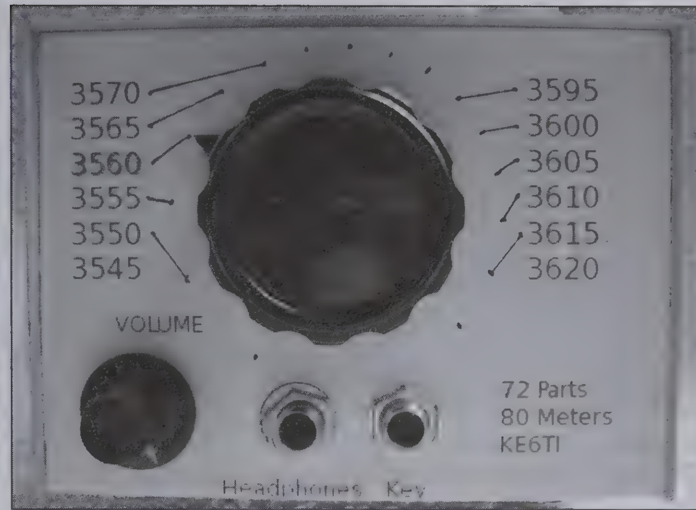
With everything in the box and working, the project may still not be finished. Does it need a calibrated dial, to let you or any operator know what frequency it's on? How about simply identifying all the controls? Which jack gets the key and which the headphones?

I am sure everyone remembers the old Dymo labelmaker, with its embossed plastic strips. If you can find one, you can use it, but it has been noted before that the aesthetics are a bit lacking. A quick trip to a nearby office supply store will turn up several more modern labelmakers that produce much better looking labels. It is also possible to produce an image of the entire front panel on the computer, and print it in one pass to a transparency or to one of the large mailing labels I mentioned above.

If frequency calibration is wanted or needed, the simplest way is an indirect calibration. Use a logging scale, either a commercial dial or a computer-generated one,



An indirect dial, with a calibration chart.



One way to do a direct dial. This is the front side of the photo on the previou spage, with a label that covers extra holes.

and create a chart of frequency versus dial scale reading. This has the advantage of looking better than a hand drawn dial scale.

It is also possible to use a computer to generate a good looking, accurately calibrated dial scale. But unless the frequency steps are very linear this can take a lot of iterations, printing out test dials and checking them against the radio itself. It is simpler, but less aesthetically pleasing, to simply use a fine point pen—artist pens with pigmented ink will not fade—to draw marks on the dial, and use the labelmaker to generate the numbers themselves.

Finally, one of the most important items any homebrewer should have is a notebook. This can be a digital notebook if, and only if, you back it up regularly. Otherwise paper is better. It is also usually quicker and easier to draw schematics on paper than on a computer. Since the notebook is for your use, not for publication, it does not have to be especially neat, just legible.

Keep notes on everything you try, whether it works or not. In fact, keep notes on anything you might ever be interested in revisiting. This includes circuits that have been tried, obviously, but also what happened to the finished project, and where you stashed the leftover parts. A well-kept notebook is worth its weight in gold. It also helps to annotate the circuit assemblies themselves with the location of the notes that refer to it. This can help enormously when trying to troubleshoot a gadget you built ten years earlier.

However you do it, I encourage any ham to try building at least some of his or her own gear. And once built, put it on the air. There are few thrills in radio as satisfying as simply saying "The rig here is homebrew."

FDIM 2014: A Report

Timothy Stabler—WB9NLZ tastabler@comcast.net

If you went to FDIM this year and has as good a time as I did, then I know you did enjoy yourself. As I have done for the past two years, I drove there and arrived Wednesday afternoon. From my home in Indiana, it only takes me about 4 hours to get there. I got in my room and that evening, I registered and got my copy of *Four Days in May Conference Proceedings*. I also got a bus ticket that goes from the hotel to the Hamvention on Friday and Saturday. I only go on Friday, mainly to see people I know there. This year, Satan Sindeev, UA3LMR, did not come to the meeting. I had written him about coming and he told me he had a new job and that he would be doing a DXpedition. It was good to see people I knew at the registration and meet others. You might notice my new email address. I got tired of finding new mail in "trash" and Yahoo was no help. Since I now have Xfinity home (TV, internet, phone and security system), I am using my new email address.

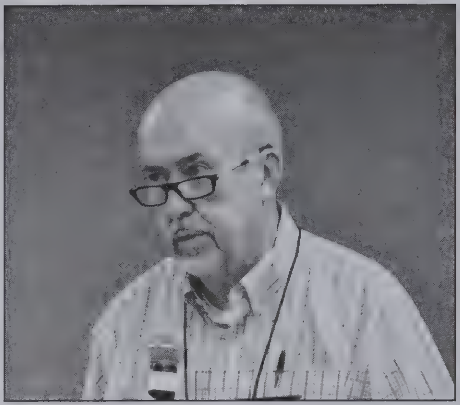


Figure 1—QRP ARCI President Ken Evans, W4DU welcomes everyone to FDIM 2014.

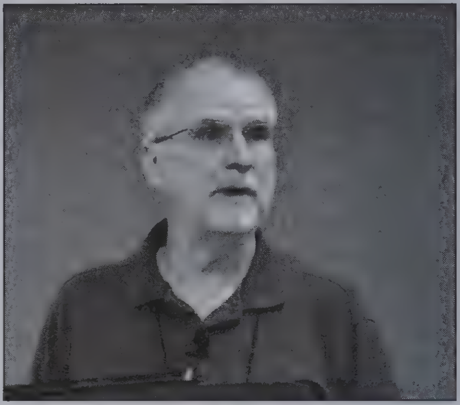


Figure 3—Harold Smith, KE6TI began the seminars by talking about the many ways to build homebrew projects.

Thursday the meeting started at 8 AM. Most of us had gotten up for the free breakfast, so we were ready to go. Ken Evans, W4DU, President of QRP ARCI (Figure 1), welcomed everybody (Figure 2) and asked if there were any first timers there. It was a surprise to see how many hands went up. I had heard there was an increase expected in the number of people there. I know Ken has spoken to the people at the hotel and there are plans if there is much of an increase next year. As I remember, the hotel started taking reservations for FDIM, 2014, right after Thanksgiving, 2013. I will have to inquire if that will be the case for FDIM, 2015. I will let you know in my Fall editorial.

The first talk was "Many Ways to Homebrew, Construction Techniques for Radio Builders" by Harold Smith, KE6TI (Figure 3). Harold started by encouraged everyone to build their own stuff. He feels everyone can do it, especially if you build and test by stages. He then went through how building things have changed over the years. The first technique was to breadboard your project. The term has survived. Then chassis and terminal strips. Today, we are in printed circuit boards. One can make their own or have them made up for them. There are several places that will do that for you at reasonable cost. You should ask what is available.

Harold demonstrated with his Colpitts crystal oscillator. He demonstrated what it looked like done on perfboard. One can also use Manhattan style building, if they prefer. One can buy pre-made pads or get a pad cutter to make their own. He also demonstrated "ugly" construction. Harold went over basic soldering techniques and told everyone not to fear toroids as the number of turns is the number of times the wire has passed through the center hole. Enclosures are used to protect your circuitry, and may be new or re-purposed. He cautioned everybody to keep a notebook on their building trials. Building is tough but it pays when you can brag about it.

The next talk was "Whitebox Handheld SDR" by Chris Testa, KD2BMH (Figure 4). Chris started off by telling us he had gotten interested in camping and back-packing. He also got into "C" programming early and now works at Google on software programming. While out on a camping trip, he looked at his smartphone and realized it could not help him from where he was if there was a problem. He felt there is now Arduino, Raspberry Pi and others and maybe ham radio was on the decline. He wanted to use the QRPer's homebrew attitude to build a software radio. He is interested in a personal interface and having the radio be an open

Figure 2—The morning meeting group.

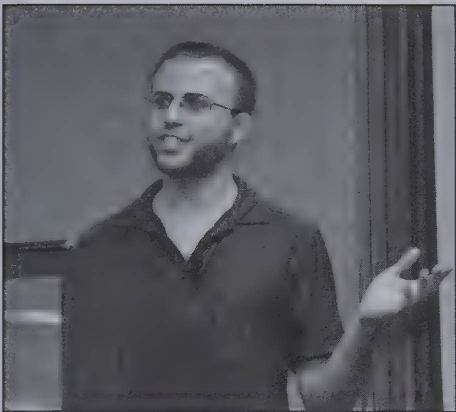


Figure 4—Chris Testa, KD2BMH, talked about his Whitebox handheld SDR.

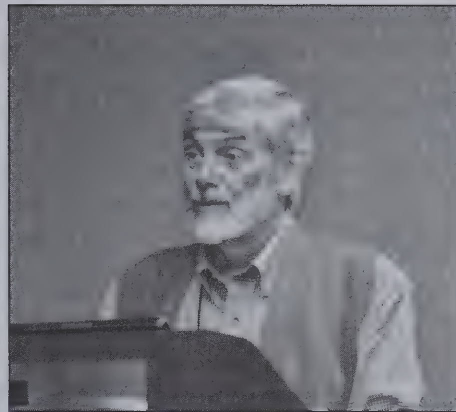


Figure 5—George Dobbs, G3RJV, discussed regenerative receivers.

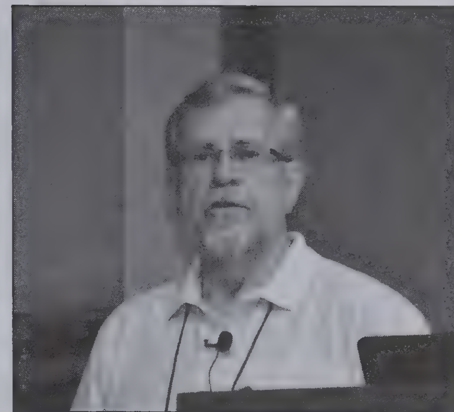


Figure 6—Gary Breed, K9AY, explained how to use an external antenna jack.

source, mentioning that *Wireless Networking* is a good reference book".

Chris went over a smartphone anatomy diagram. He pointed out that the antenna is in the case and noted out that motherboards are getting smaller so batteries can be bigger. In the conference proceedings book, Chris gives information on building such a rig and answers questions using terms over my head (!). Fortunately, he also includes a page of references.

The third talk, "The Classic World of the Regenerative Receiver", was given by George Dobbs, G3RJV (Figure 5). George started off telling us where he is from and that he did teach at a grammar school for half a day where he met another radio amateur and they started a radio club there. Determined to teach his students some of the pleasure of radio construction he devised a step by step radio construction course. One student's father worked at Ladybird Books, which publishes a range of books for children. He invited George to convert his project into a book which still appears from time to time

George has published several different radios and feels his interest came from his parents buying him a shortwave radio kit. *Fun with Radio* is a book George still owns and has used it to inspire some of his early radio projects.

People still build regenerative receivers. He spoke on the winding of coils to get everything working in phase. In England one gets inductors. He mentioned that David Richards, AA7EE, uses Me Squares for his Manhattan building. He then went over several different circuits which have been used. A good internet place to see many things is www.mds975.co.uk. Children love regenerative receivers as they are simple and analog. Many of the pieces we now use, such as the LM386 does not perform as we want it to. His final internet site given was www. amateurradio.com for information you might want to have.

The fourth talk was "Why Does My Radio Have a Receive Antenna Jack?" by Gary Breed, K9AY (Figure 6). Gary pointed out that many radio transceivers have a "receive only" jack. When operating, it is about hearing the other guy. QRP refers to transmit power. There are no QRP receivers, so if you can hear better, then you can work more stations. You want to reduce noise in the received signal and a directive antenna can help that. He pointed out that a transmit antenna does not always have directivity, so a separate receive antenna would be a good addition. A simple switch to have access to both antennas is a good thing to do.

He used Elecraft and Flex radios as examples of ways that antenna jacks are implemented, usually allowing the receive antenna to be disconnected while transmitting. Once you have decided to use a receive only antenna, there are many to choose from. Gary went over several of them and pointed out the *ARRL Antenna Book* as a good one to start with. He pointed out that by using a receive antenna connection, you also have a way to hook in your preamplifier, attenuator or filters. Gary knows we do not always pay attention to how everything works together and hopes this gets you thinking how to make your pieces work together well.

The next talk was "The Great Arduino.

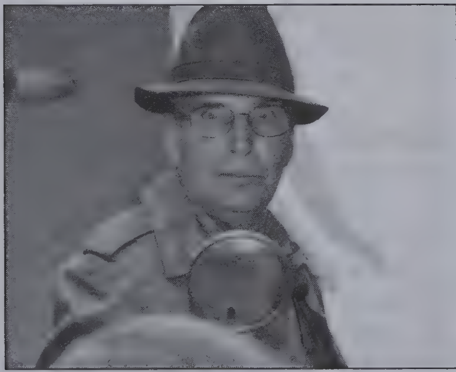


Figure 7—Craig Behrens, NM4T, as his Peter Gunn character.

Figure 8—Craig discussing Huntsville with Martha Aucherd, WØERI.

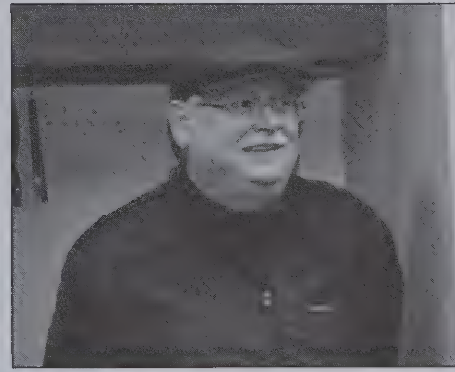


Figure 9—Glen Popiel, KW5GP, as the "skunk" who wanted JT65.

Figure 10—Dave Cripe, NMØS talked about a WW II clandestine receiver.

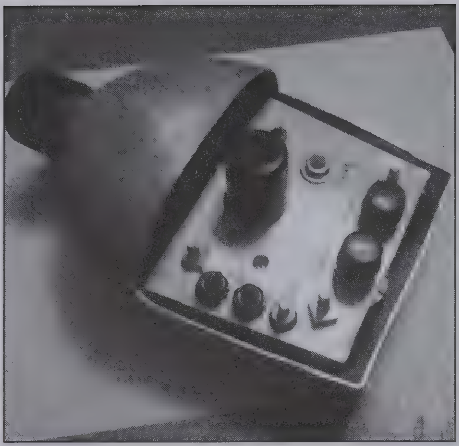


Figure 11—NMØS' replica of the POW receiver.

JT65 and Rebels Caper" by Craig Behrens, NM4T (Figure 7). Craig came onto the stage with his "Peter Gunn" outfit on. Then on came Martha Aucherd, WØERI (Figure 8), to have a discussion about the Huntsville QRP forums. What this started was a light discussion of the Arduino, JT65 and the new TEN-TEC Rebel transceivers. As you might know, TEN-TEC introduced the Rebel last year at FDIM and told everyone the Rebel had an "Arduino with steroids" in it. They made the Rebel with an open source radio so you can reprogram it back to where you started anytime. JT65 was originally developed by Joe Taylor, K1JT for EME (moonbounce) work.

Craig had gone to St. Lucia with Rob Suggs, KB5EZ, Glen Popiel, KW5GP and Joe Large, W6CQ. They called themselves the "Skunk Werks". They wanted to have a small group so they could get to know each other and work off of each other. They wanted to have a team each one could trust. No one was the "team manager". Glen came on the stage in his older clothes (Figure 9) to have a "skunk" talk with Craig about the Rebel. He felt it could be programmed to do JT65. It had been done and the first QSO was with W3BI. Note: The code is available for your Rebel. They had rented a chateau which overhung a cliff. The local club was very instrumental in getting everything set up. It was a good session there. Craig made over 1000 contacts using his call and over 13,000 using the club call. They did a mentorship with the young people there as they wanted to invest time with them. As Craig said, you want to prove to your audience that you can walk in their shoes.

The last talk was "POW QRP An account of WW2 Clandestine Radio in the Pacific" by David Cripe, NMØS (Figure 10). In the 1920s and 1930s, radio was in a golden era. Boy Scouts had their wireless merit badge. In the depression, radio was still golden as it allowed people to away from the Depression. All sorts of magazines had radio construction projects. Radio operators were sought after. The Army Signal Corps recruited them. Then, along came Pearl Harbor. The Japanese took over many islands and prisoners taken were forced to march long distances usually without food or water. Camps were in very bad conditions and prisoners were treated harshly. They were told how the Japanese were really doing a job on America. The prisoners were searched regularly. One prisoner taken was Russell Hutchison, who had originally come to the Philippines for horses. He told them, he could do radio work and was assigned to fix their radios. He got word out he needed a tube and quietly got a 12SK7 from a downed warplane. With parts he was able to smuggle out, he built a radio in a 2 x 4 and put it in the latrine so he could use that electric power. He was able to hear KGEI and hear how the war was really going. With a transfer looming, he took his parts and sealed them into food cans. The cans were opened by other prisoners and the parts lost. At his new site, he finally got the parts for a radio which he put in a canteen so the radio would not be noticed. He was eventually moved to work in Japan and the radio was lost. After the war he did return home to Barbara and 4 kids. He passed away in 2003.

Dave read about the canteen radio and wanted to build one. From Ebay, he got a WW II canteen. He looked over circuits that may have been used then and decided on a Hartley Oscillator. He wanted to use period parts and had bought a pre-WW II battery radio. He was going to re-build it, but could not as a previous owner had tried to make it into a regular AC radio. But the parts were good. He cut the canteen so it would go into its holder and would give him room for the radio. He wanted to use a 12 V supply for the filament and plate. Dave built the radio and was crushed when it did not work. He realized he had two screen connections reversed. After that was repaired, 40 M came in fine. This is really an interesting radio to look at (Figure 11).

That night was the buildathon (Figure

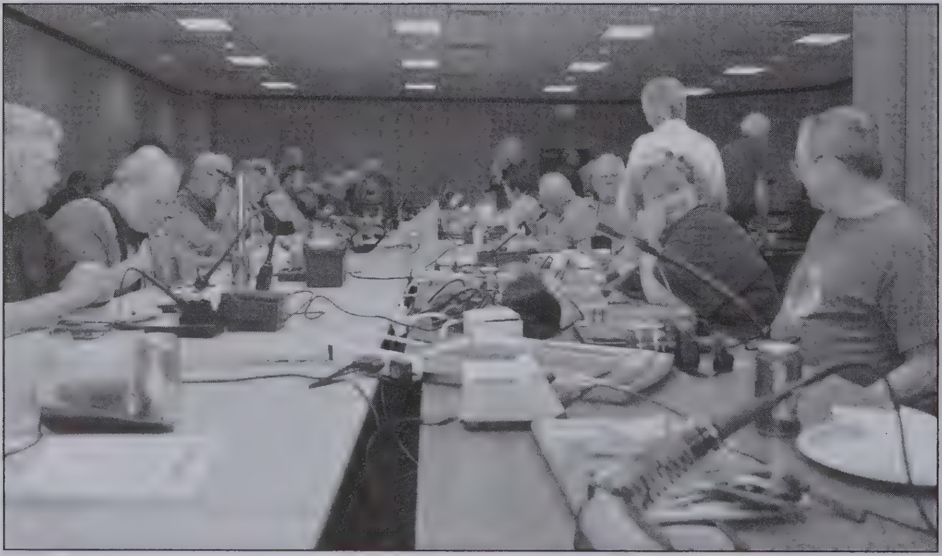


Figure 12—The Buildathon is underway!

Figure 13—The TEN-TEC Patriot SSB open-source radio, announced at FDIM's vendor night.

Figure 14—Here is a group that gathered for FDIM's Club Night.

Figure 15—The escape bar in the Space Shuttle demonstrator.

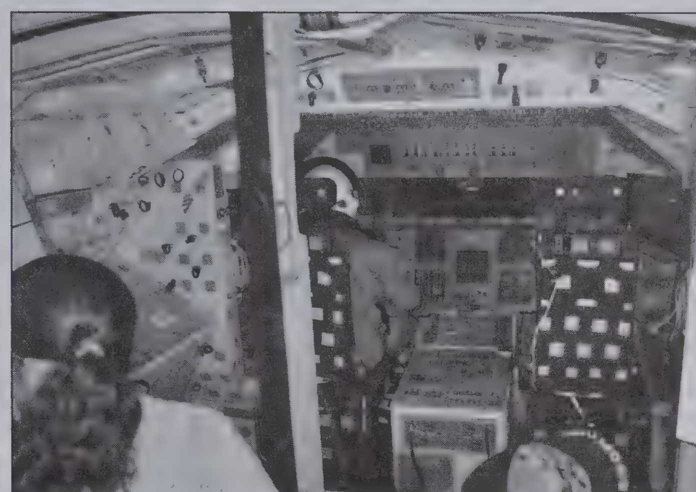


Figure 16—The Shuttle cockpit.

12), led by Rex Harper, W1REX. His project this year was a QRPpp HAMstick Project. This would introduce the builder to several different sizes of components and styles of soldering. It serves as a development platform for using and learning Picaxe micros.

That night, Jim Wharton, NO4A , had a roomful to hear his announcement of the new radio from TEN-TEC. It is the Patriot, Model 507 (Figure 13). Like the Rebel, It has an Arduino in it and is an open source radio. The new addition is that it does SSB. It comes with 2 bands (20M and 40M) and put out about 5 watts of power. The price tag is $399. It does have a button for changing bands. Unlike the Rebel, no jumper is needed.

Thursday night was also the vendor night. It was interesting to see the various items that were on sale. Like many others, I looked but did not buy. I had only been in my new house for about 2 months and was still unpacking boxes. Next year I will know what I want or need.

Friday morning, I had breakfast early so I could get the first bus to the Hamvention. This year we had the bus services of Wilbur and his son, Wil. The buses ran 7:30-9:30 to get you there and then 3:30-5:30 to get you back to the hotel. Again, the cost was $15 and the ticket was good for both Friday and Saturday. I went Friday and got well worn out. Friday night was also the Club Night. Several clubs (12 were pre-registered) were set up and very willing to tell you all about their club. I did get a picture of several club members all together (Figure 14).

Saturday, I went to the Air Force Museum, which is near the hotel. I wanted to see the plane that took Kennedy to Dallas again. Last year, Congress did not allow that trip. When we got back to the Museum, it was a mob scene. That weekend was the "Space Flight" event. They were expecting about 7000 visitors. I did get the chance to talk with a volunteer I talked with last year and he told me about a bar I should notice in the shuttle. If there was a problem, the bar could be moved outside of the shuttle (Figure 15), the astronauts would hook their lanyards up to it and bail out. The bar was designed to take them out further than the wing so they could drop off and engage their parachute as they fell into the atmosphere. Basically, the shuttle was a mock-up except where the pilots were sitting was real. It was the trainer they had used for their training (Figure 16). Two astronauts were there for autographs. Since I had seen the Kennedy plane again, I did not

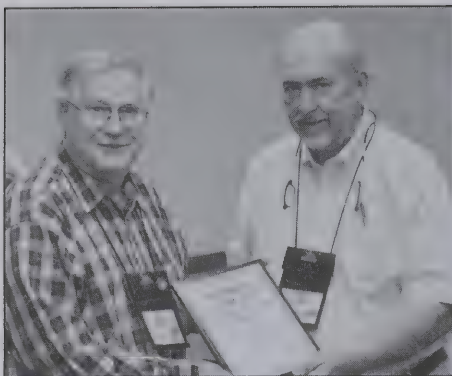


Figure 17—Richard Meiss won the Accessories category of the homebrew contest.

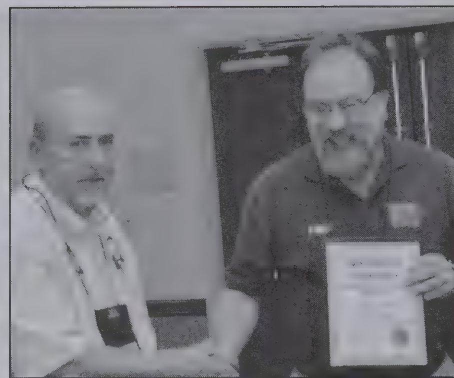


Figure 18—David Cripe receives his homebrew contest award from Ken, W4DU.

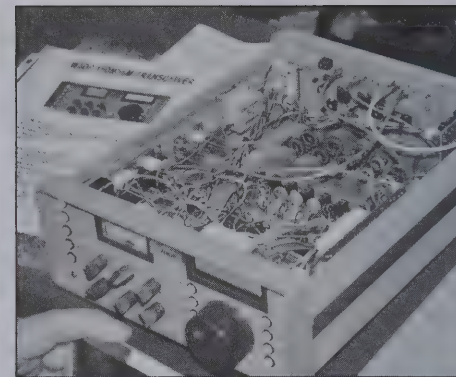


Figure 19—Dale Parfitt was not at the banquet to receive the award, but here is his winning transceiver project.

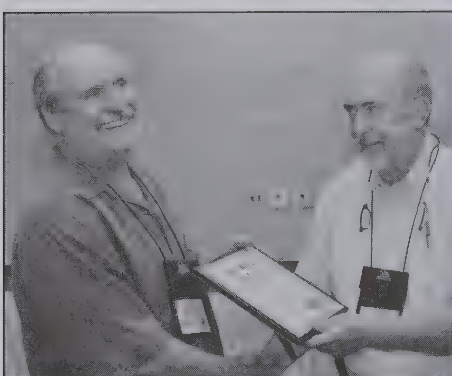


Figure 20—Ward Harriman, AE6TY has a laugh with Ken, W4DU as he receives his homebrew award.

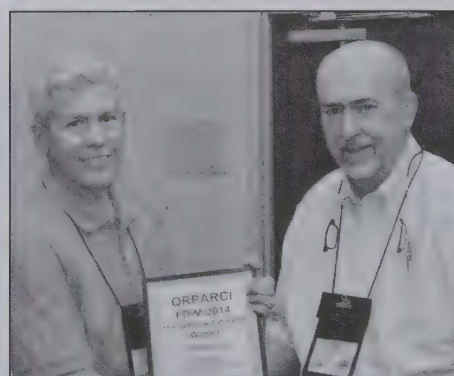


Figure 21—Ken awards John Poland, N8TRL the certificate for his winning antenna.

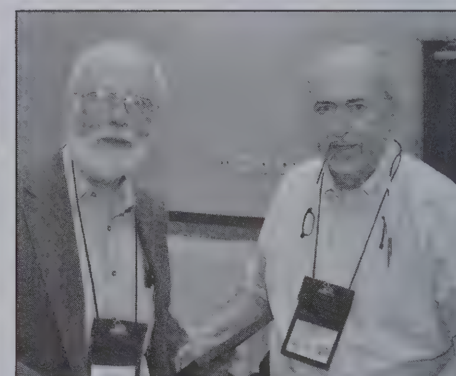


Figure 22—Charles Rabley received a top homebrew contest award for his crystal set.

stay at the museum very long.

That night was the banquet. Tickets were distributed to each seat for the door prize drawing. Awards were first given to the winners of the homebrew contest. These included Richard Meiss (Figure 17), WB9LPU, for the 100 class, Accessories; David Cripe (Figure 18) for the 200 class, Transceivers; Dale Parfitt, W4OP (Figure 19), for the 300 class, Scratch Built; Ward Harriman, AE6TY (Figure 20), for the 400 class, Test Equipment; John Poland, N8TRL (Figure 21) for the 500 class, Antennas; and Charles Rabley (Figure 22), WA8RUO, for the 600 class, Crystal Sets. I hope I got all the names and callsigns correct! I also hope the pictures are correct, since we are a bit unsure of my notes and those of other ARCI helpers.

Next up was the awarding of membership in the Hall of Fame. Complete write-ups for each person are in this issue under the President's column. These included Ed Hare, W1RFI (Figure 23), David Cripe, NMØS, and Zack Lau, W1VT. As I understand it, Zack was not at this meeting. But I give hearty congratulations to them all.

Prizes were then drawn using the tickets passed out earlier. This was when my camera decided not to work as it should, so I do not have photographs of these winners. The first two prizes were for Begali keys and were presented by Mr. Begali himself. They went to David Wilson, KU4B. and Ron Doyle,N8VAR. ,Other winners included Pat Tessey, KCØYWV, Jim Rotorto, WB6NJA, Chris Schenk, KN6CS, Ed Kwik, AB8DF, Matt Gibbs, WA8AQS, Karl Demuth, N8PKB, Jean Kena (YL of Mike, AA9IL Ken Evans, W4DU and Kathy Bromley, WQ5T.

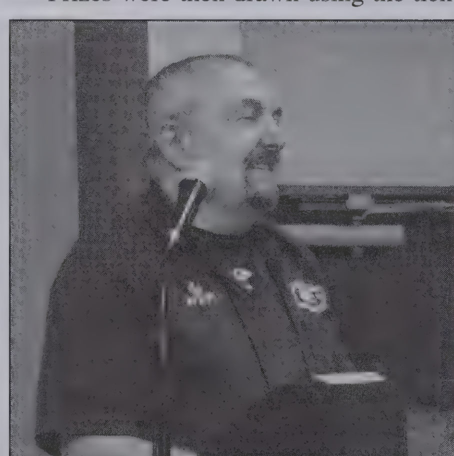


Figure 23—Ed Hare, W1RFI, was one of three inductees into the QRP Hall of Fame announced at FDIM.

The final prize was the drawing for the Grand Prize, a raffle item that people bought tickets for. The Elecraft KX-3 went to Lawrence Kolodziej, KC2VFX.

The next morning, I got my stuff in my car and headed home to Portage, IN, and my new home. It had been a very good trip and I am already planning for next year's trip. If you were there this year, I hope you are doing the same. ●●

An Auto-Tuned Mag-Loop Antenna

John Lonigro—AAØVE

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The following article originally appeared in the June 2014 edition of the Ozark QRP Banner *and is reprinted here with the kind permission of the editor of that fine publication. —Ed.*

On April 16th, 2014, I was fortunate enough to win the "Best of Show" with my auto-tuned loop antenna entry at the annual St. Louis QRP Society's (SLQS) Builders Contest. This article will explain in general terms how it works and my plans for it in the future. Let me begin by saying the entire concept of making loop antennas was brought to my attention by Dave, NFØR, who, many years ago, began using an old bicycle rim as the loop. I pride myself in the fact that one of his loop antennas is made using a rim from my old bicycle. Larry, NØSA, also contributed to the project by pointing out an alternate way to match the loop, using a Gamma match rather than a small coupling loop. He also recommended some of the components I ended up using, specifically the "Big Easy Driver".

One feature of a mag-loop antenna is its very narrow bandwidth. It is essentially a high-Q resonant LC circuit tuned to the frequency of interest that also happens to radiate. Being high-Q is a good thing because the antenna itself becomes a narrow front-end filter, making for very quiet reception. It's also a bad thing when it comes to tuning the loop. Virtually every time you change frequencies on your radio, you need to tweak the antenna tuning to keep it resonant. Tuning is accomplished on my loop by adjusting the other half of the resonant loop circuit, a variable capacitor in parallel with the loop. Tuning is so touchy that stray capacitance from any source such as your hand is enough to detune the loop. Even getting close to the loop can detune it. Therefore, the best way to use most loops is to have them close enough to adjust while scanning the bands but far enough away to keep from detuning them. Having a loop in the backyard or attic while operating from the basement is out of the question, unless there were some way to remotely tune the antenna from the shack. That's what drove me to come up with a way to auto-tune a mag-loop.

Antenna Unit

Unlike a typical auto-tuner, which has an array of capacitors, inductors, relays, and a sophisticated program to intelligently and quickly switch in various combinations until a low SWR is obtained, a loop auto-tuner only needs to adjust one component to find resonance, the variable capacitor. I decided to go with a stepper motor rather than a geared-down continuous motor, mainly because stopping the continuous motor without having it overshoot its mark seemed more difficult than using a stepper. The motor I chose has 1.8 degree full steps. The Big Easy Driver stepper controller allows steps as small as one-sixteenth of a full step. Throwing in a 6:1 reduction drive between the motor and capacitor, it is easy to show that 180 degrees of capacitor rotation can be broken down into 9600 discrete steps of the motor if desired. The capacitor is 200 pF (two 400 pF sections in series), which means I can adjust it by as little as 0.02 pF, more than enough for this application. Figure 1 shows a little of the copper loop, the capacitor, the reduction drive, and the stepper motor. I used a universal joint with a rubber spider to both isolate the motor from the capacitor and to allow a little bit of shaft misalignment.

Once I had the capacitor attached to the stepper, I needed to figure out how to tell when the antenna was resonant. I got my idea from the SWR indicator kit sold by www.qrpkits.com and designed by Dan Tayloe N7VE. His indicator design uses a simple bridge circuit, with the antenna acting as one branch of the bridge. If all four branches are 50 ohms, the bridge is balanced and the error voltage is very close to zero. In his implementation, there is a DPDT switch to switch the bridge into and out of the antenna circuit. The AC error voltage goes through a transformer, is rectified, and drives an LED. When you tune the antenna, the brightness of the LED dims as you approach resonance. For my implementation, I replaced the switch with a DPDT relay and eliminated the LED

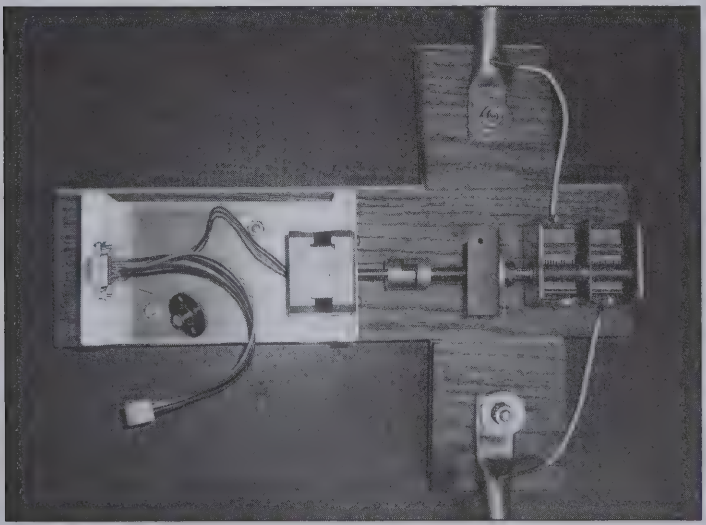


Figure 1—Stepper motor and 6:1 reduction drive attached to variable capacitor

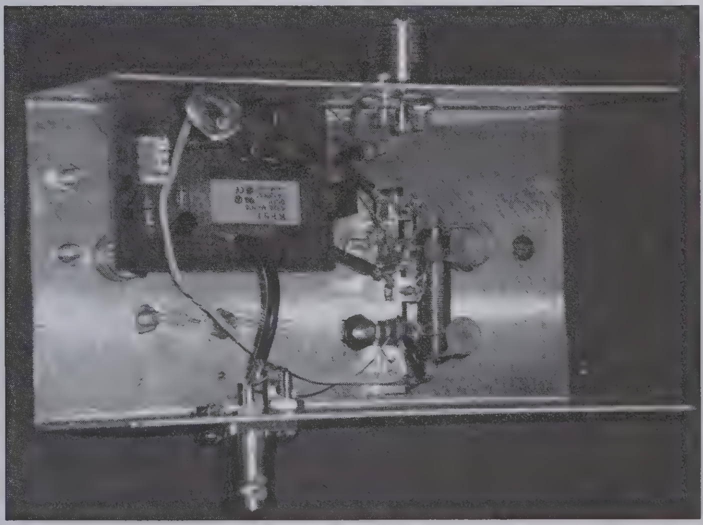


Figure 2—SWR bridge, plus the bias-T on the right.

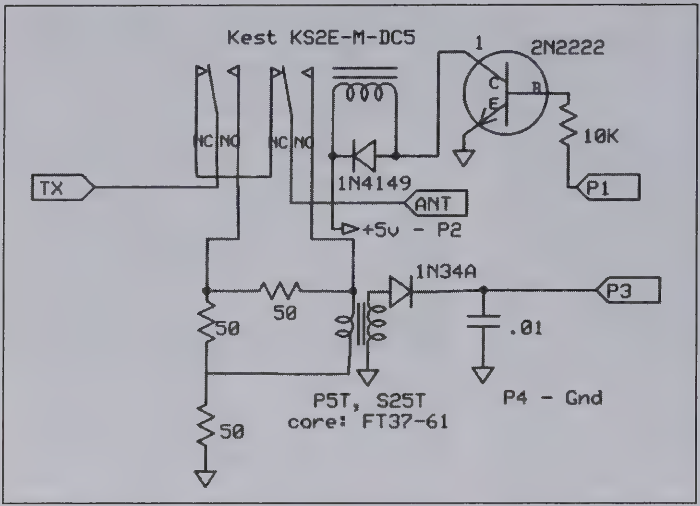


Figure 3—SWR bridge schematic.

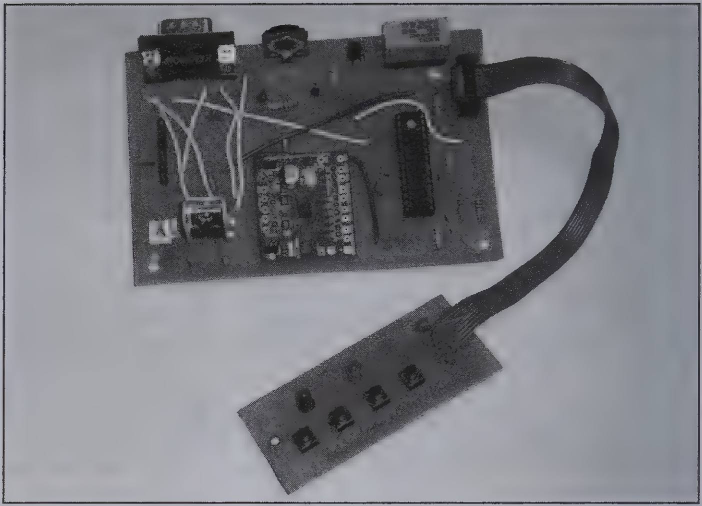


Figure 5—Main board and front panel.

altogether. All I needed was the error voltage, not a visual indication. Figure 2 shows my SWR bridge, including a relay driven by a 2N2222. Other than the coax coming from the rig and going to the antenna, I needed 4 wires to go to this bridge: +5 volts for the relay, ground, a control signal to turn on the 2N2222, and the resulting rectified error voltage. When I want to see what the error voltage is, I turn on the relay, key the rig, and measure the voltage. I can adjust the capacitor for minimum error voltage and then unkey the rig and turn off the relay. Another good thing about the bridge is the impedance seen by the transmitter is never too far from 50 ohms, which is good for the transceiver finals.

Also evident in Figure 2 is a terminal strip with some capacitors and an inductor attached to it. This is a bias-T circuit which I plan to eventually use to send control signals to the tuner over the coax coming from the rig. That is next year's project and is not used in the current design. The plan for the bias-T, designed by Phil Salas AD5X, is from the January, 2013 issue of *QST*. The schematic of the bridge circuit is shown in Figure 3. It turns out the transformer secondary can be 10-15 turns, but it works with 25 turns and I didn't want to redo it.

Before leaving this portion of the design, refer to Figure 4, which is the completed loop connected to the stepper motor. Evident in the figure is the SO-239 connector for the coax and a thin piece of coax coming from a BNC connector on the other side of the case and going to a balun at the top of the loop. Barely visible is the gamma match going from the balun to a point on the loop at about the 10:30 position. The optimum gamma match tap location varies with frequency, but the location chosen produces an SWR near 1:1 throughout the tuning range of the loop (40 - 15M).

The Main Controller Board

At this point, we have the mechanical means to turn the capacitor and a means to measure the error voltage coming from the SWR bridge. What's needed is a controller to tie these together. I used an Arduino Uno for my initial feasibility study, but didn't want to hard-wire that into my final design,

Figure 4—Loop antenna and stepper motor/SWR indicator assembly.

partially due to expense and partially because it has a fairly large footprint. What I ended up choosing was something called an "Ardweeny". This clever device is essentially an Arduino minus the USB-serial conversion part. A small circuit board contains a few components (LED, crystal, pushbutton, headers, and a few other components) and is mounted piggyback on the Atmega 328.

The problem I found with the Ardweeny is you are required to solder the headers to the very top of the IC pins and I managed to damage the chip with excess heat. My final design incorporates the same schematic but the parts were relocated to my main PCB and the Atmega 328 plugged into a socket after all soldering was finished. Figure 5 shows the completed main PCB attached to a control panel PCB with pushbuttons and LEDs. As is obvious, when I designed the PCB, I didn't spend a lot of time trying to minimize the number of jumpers required. That many jumpers may not look professional, but with a single-sided board and so few components, it is virtually impossible to eliminate all jumpers anyway.

Referring to the figure, near the top of the board are a DB9 connector, a trimmer to adjust the voltage coming from the SWR indicator, and a keying relay controlled by a 2N2222. The DB9 connects the main board to the stepper motor and SWR indicator located at the base of the antenna. The surface mount board in the middle is the Big Easy Stepper Motor Controller, which I did not build. That board needs 12 volts for the stepper motor

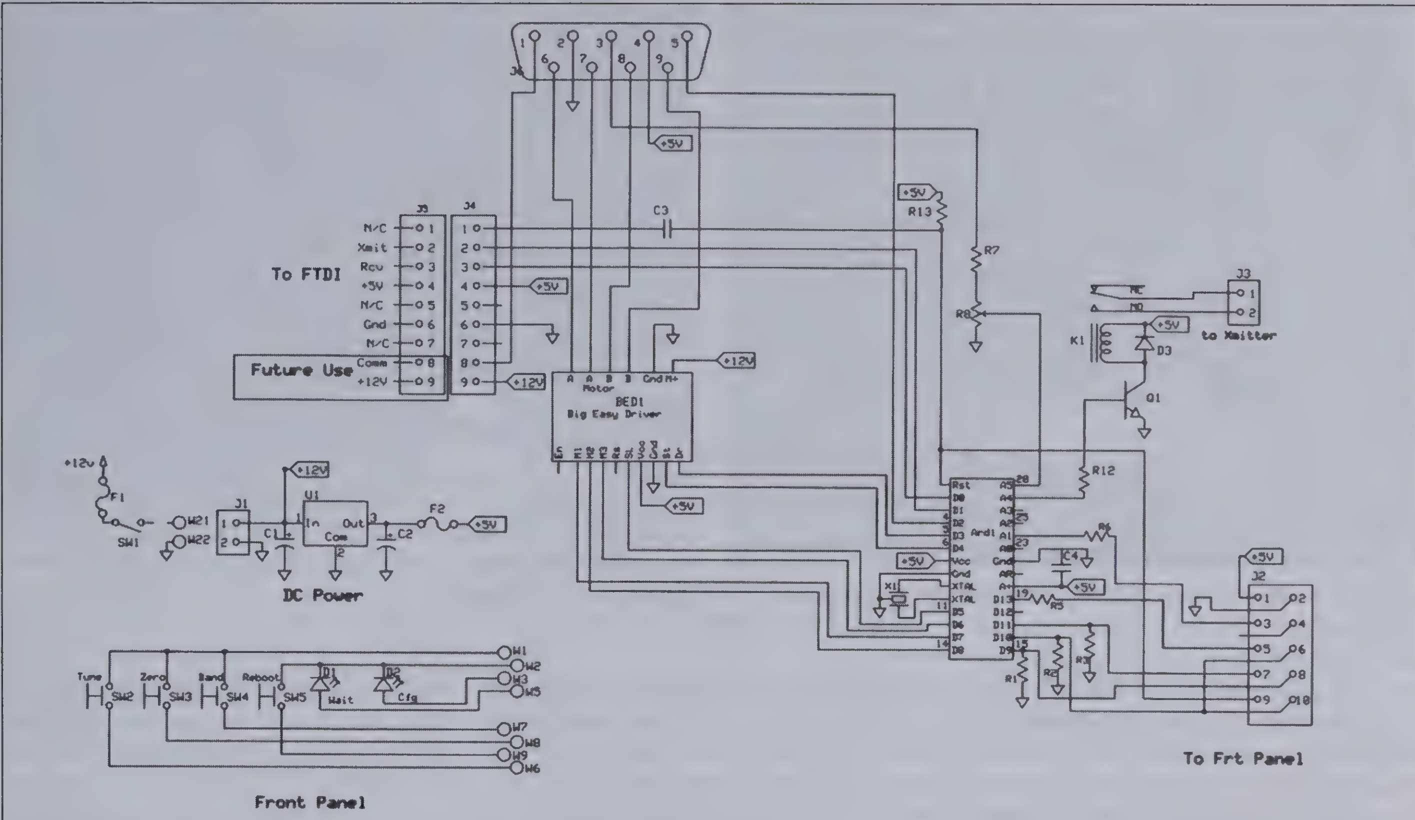


Figure 6—Main Board and Front Panel schematic.

and includes its own 5 volt regulator capable of powering the Arduino. I disabled this regulator, fearing it wouldn't be able to handle the Arduino, controller, two relays, and the LEDs. Instead, visible on the lower left is a 7805, which can handle more than enough current for this circuit. The 12 volt power connector is visible to the left of the 7805. The header right above that is where I plug in an FTDI USB-serial programmer. That device allows me to program the 328 (shown on the right on the board) as well as to have the program send debug statements to a terminal on my computer. The FTDI programmer measures a whopping 7/8" × 5/8". When programming and debugging are finished, the FDTI programmer can be removed and used on my next project, if I don't lose it first.

Main Controller Board Schematic. Figure 6 is the schematic of the main board and control panel.

I don't intend to discuss the entire schematic in gory detail, but will point out a few things to help explain how it works. The DC Power section sends 12 volts to the Big Easy Driver (BED) and provides 5.0 volts for the rest of the circuit. The front panel consists of 4 pushbuttons and 2 LEDs. The "Tune" button tells the program to commence tuning. The "Zero" button tells it to bring the capacitor back to the "home" position, plates fully meshed. The "Band" button selects which band the antenna is to be tuned to. The "Reboot" button grounds the reset pin of the Atmega 328 Main Processing Unit (MPU) to restart the program. When any of the other three buttons is pressed, 5 volts is sent to a pin of the MPU. If the MPU happens to be watching that pin, the 5 volts is a signal telling it to do something. The red LED lights mainly to tell the operator that something is indeed happening. The blue one blinks to tell which band you have selected. They will light whenever the MPU sends 5 volts to the pins the LEDs are connected to. Notice the pushbuttons are inputs to the MPU while the LEDs are outputs from the MPU.

The main purpose of the MPU can be summarized as follows:

1. It watches the 3 digital input ports (D9-D11), to see if a pushbutton has been pressed.
2. It sends either 0 or 5 volts to the digital output ports (D2-D8, D13, A1, and A4).
3. It watches an analog input port (A5), to measure the SWR error voltage coming in.
4. It runs the program that tells it when to do all these things.

There are two digital pins, D0 and D1, which connect directly to the FTDI interface. They are the serial communications ports, responsible for loading the program from my desktop computer to the MPU. During debugging, they also send data back to the desktop, to a terminal program that allows me to see what the program is doing. This is invaluable during the programming/debugging phase, but not necessary once all is working properly.

The program operation will be described in general terms a little bit later. We will first quickly discuss the Big Easy Driver (BED), shown as a rectangle in the middle of the schematic. The output of the BED has two terminals labeled A and two terminals labeled B, which go directly to the stepper motor via the DB9 connector at the top of the schematic. Other than the terminals labeled Vcc and Gnd, all the terminals at the bottom of the BED are inputs

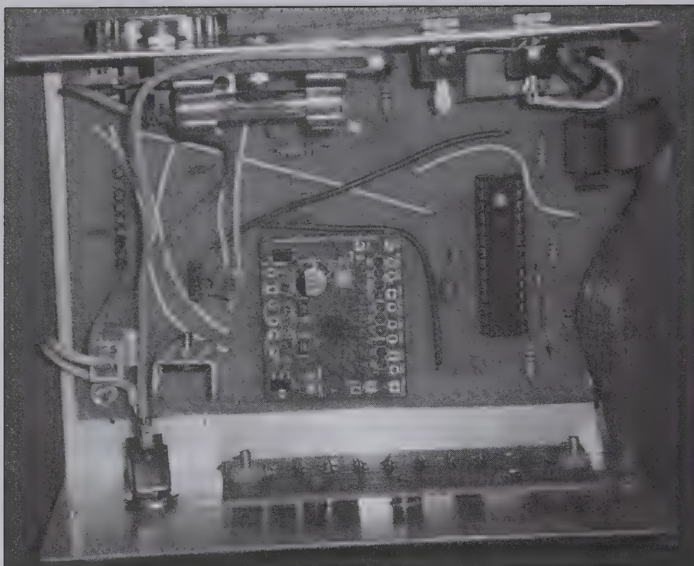


Figure 7—Finished control unit with the cover removed.

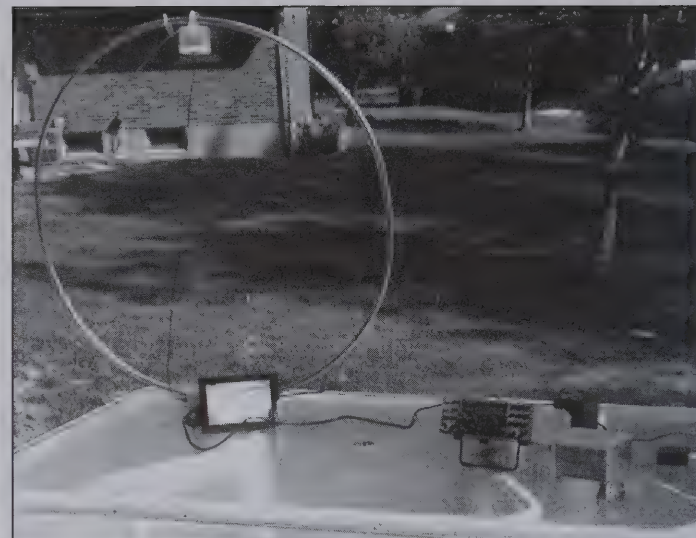


Figure 8—Finished auto-tuner in operating position (plus Best of Show plaque).

which tell it what to do. For example, "SL" is the sleep pin. If grounded, the BED is turned off, preventing any processor noise from making it to the antenna. +5 volts turns it back on. "Dr" is the direction pin. If grounded, the motor turns in one direction. If +5 volts are applied, it turns in the other direction. The signals on M1, M2, and M3 tell the BED how big of a step is desired. If all are grounded, it takes a full step, which is 1.8 degrees. If some or all are at +5 volts, it takes various smaller step sizes, down to 1/16th of a full step. Finally, "St" is the step command. Whenever a 5 volt pulse is sent to this pin, the motor takes one step, determined by M1-M3, in the direction indicated by the "Dr" pin. That's about all you need to know about the BED.

Pin 3 of the DB9 contains the error voltage from the SWR indicator. That voltage goes to the voltage divider R7 and R8, the output of which goes to an analog pin on the MPU. The voltage at that pin must be within the range of 0 to +5 volts and when read is internally mapped to a number from 0 to 1023. If I know the power output of the transceiver will be 5 watts or less, I can adjust the trimmer such that no more than 5 volts will ever show up at the analog pin. I don't know if the variable capacitor or the SWR relay can handle much more than 5 watts and I don't intend to do any destructive testing to find out. As a result, I'm rating this antenna at 5 watts maximum and have adjusted the voltage divider accordingly.

The remaining circuit in the schematic is a relay, K1, which will key the rig when told to. Figure 7 shows the finished unit with the cover removed. The eagle-eyed readers might notice a slight change from Figure 5. The resettable fuse, located just above the 7805 regulator, is no longer soldered directly onto the board. I put a small header there in order to remove the fuse if desired. Five volts are available from the FTDI USB interface when it is plugged in. I didn't like the idea of 5 volts coming from two independent sources, so I made the fuse removable, to disable the internal 5 volt supply.

Putting it All Together

When switched on, the MPU begins to run the tuner program. It first sits there, patiently waiting for one of the 3 pushbuttons to be pressed. If the 4th button is pressed, it's the same as switching the device off, then on again, so we won't discuss that further. When pressed once, the "band" button tells the MPU we are interested in the lowest band (40M). If pressed again, we are interested in the next band (30M). The loop works up to 15M, so I currently allow 5 bands. As you press that button, the blue LED flashes to indicate which band has been chosen (1-5). If you press the button 6 times, it goes back to band 1, etc. The program is calibrated to know about where the tuning capacitor needs to be for the lowest part of each defined band. It also knows about where each band ends. For example, out of the 9600 capacitor settings possible (microsteps), let's assume the 40M CW band goes from location 1000 to 1100, corresponding to 7.000 MHz to 7.150 MHz. To allow for reduction gear slippage and imperfect motor stepping, I might define the 40M CW band as going from 900 to 1200 microsteps. The "band" button doesn't make the motor move. It just makes a note of which band is desired.

When the "tune" button is pressed, the first thing the program does is see if the desired band is the same as the current band. After all, it's possible that the "band" button was pressed enough times that it ended up set to the same band the antenna was already tuned to. If it is a different band, the capacitor is quickly moved to the lower end of that band. Then it performs the following steps:

1. Turns on the SWR indicator relay and delays to make sure the contacts have closed.
2. Keys the transmitter and delays to make sure the transmitter keying relay contacts have closed.
3. Waits to make sure the transmitter has reached maximum power.
4. Steps the capacitor a little, checks the SWR bridge voltage, determines if the voltage is decreasing.
5. Keeps track of the lowest SWR bridge voltage and stores the setting that produced it.
6. Continues to step the capacitor until it is sure it has tuned through the res-

onant point and is on its way back out of resonance.
7. Unkeys the transmitter and turns off the SWR indicator relay.
8. Moves the capacitor back to where the SWR bridge voltage was lowest.
9. Turns off the Big Easy Controller, to eliminate receiver noise.

If the band hasn't changed, it is considered a "fine tune" only. The capacitor is moved down a few steps, then the above process is pretty much repeated. Modifications that are currently in work include using a finer motor step, especially for 17 and 15M. Tuning gets more touchy as the frequency increases and a finer motor step will be able to get closer to resonance. A quarter step is sufficient to tune 40M through 20M, although a finer step won't hurt. The "zero" button is used to park the capacitor with the plates fully meshed, to protect it while in transit or to prepare for a reboot. Whenever rebooted, the program assumes the plates are in the starting position, i.e., fully meshed.

While I described the algorithm in a few short paragraphs, the actual program is around 600 lines of code.

Future Plans

This is part I of a two part (at least) project. I currently have a 6' cable going from the control unit to the antenna. That allows 6' of remote operation, enough to help if the antenna is on the same picnic table as the radio, but hardly enough if the antenna is in the attic. See Figure 8. The 6' cable was used because I could buy one with ferrites on each end for less than $2.00. I couldn't buy the connectors, let alone the cable and ferrites, to make my own cable for $2.00. I doubt the device will work with a 50-75' cable, but even if it did, I don't want to run an extra cable between the antenna and the shack.

There are other shortfalls as the design currently stands. For one thing, the transceiver needs to be set for hand key operation. When keyed in paddle mode, producing a string of dits or dahs will only confuse the program and certainly won't find the proper resonance point. So at this point, I am stuck with using an external keyer.

My future plans will include at least the following:

· Make a second unit that will be sitting in the shack, connected to the K2 (or other smart transceiver).

· That local unit can communicate with the K2 as well as with the control unit near the antenna. Communi-cations with the K2 would be via the serial port. Communications with the unit at the antenna will be through the coax via two bias-T circuits, one in the local unit and one in the control unit at the antenna.

· When a tune is requested, the local unit can switch the K2 to hand key input. After tuning, it will switch the K2 back to paddle input. This will all happen rather quickly and won't inconvenience the operator at all. Furthermore, the K2 can be queried as to which band it is on, to eliminate having to manually set the tuner to the correct band.

· A hardware mod that needs to be made is isolating the key jacks from ground. I plan to accomplish that by eventually mounting those jacks on a piece of acrylic.

Conclusions

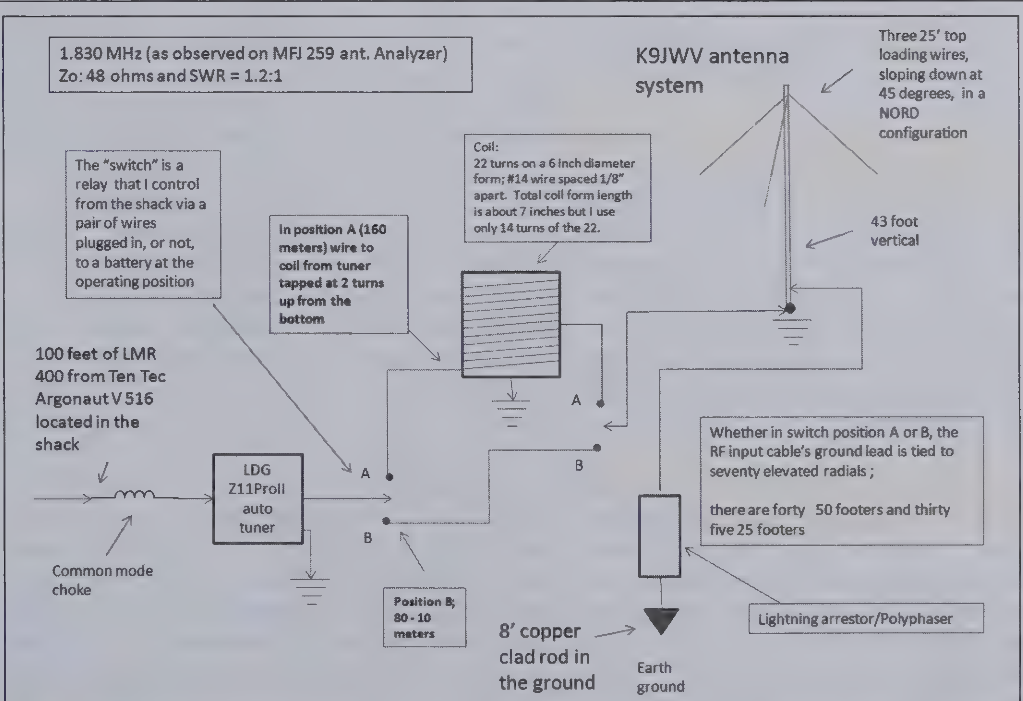
This has been a fun project. I've worked on it part-time for about 18 months and have learned a lot about the Arduino in the process. I don't expect my future plans to be implemented by Field Day 2014, but I'll make sure it can do a good job of tuning when the radio is 6' away from the antenna and hope to use it at least a little during that weekend. As of this writing, the software hasn't been cleaned up, but if anyone is interested in seeing the nitty gritty details of how it was done, he is welcome to contact me and request the latest version of the C-code that is available (no warranties expressed or implied).

—73, John Lonigro, AAØVE

Errata

There were errors in Figure 11 of the article "Operating Low Power on the Low Bands," which appeared in the Spring 2014 issue of *QRP Quarterly*.

The corrected figure appears here.



QRP Contests

Jeff Hetherington—VA3JFF contest@qrparci.org

CQ CQ CQ TEST CQ CQ CQ TEST QRZ

DE VA3JFF 559 ON ARCI NR 9223

SRI OM WRONG TEST … CQ CQ CQ TEST CQ CQ CQ TEST QRZ

I have been hearing after every contest that this has been a growing concern. Every weekend the bands are crowded with contests, sprints, QSO parties and other operating events. Throw in those calling CQ for casual QSOs and the bands can get very crowded, especially around the QRP calling frequencies. Everybody comments that it is increasing difficult to make contacts as a casual contester, but what really can be done? There are only a few suggestions that regularly come forward:

1. Schedule QRP-ARCI events on different weekends— Sounds simple enough, but a quick look at the contest calendars show that there are no "free weekends." Every weekend has a handful of contests going at the same time, and the best of scheduling will not be able to keep you free of QRM. Just think—there are 50 States, and 52 weekends—nearly the entire year could be taken up with State QSO Parties alone. Throw in national contests from several DXCC entitites, and the "Major Contests" for each year, and there is heavy competition on the bands weekly.

2. Increase participation for each QRP-ARCI sponsored event— This would be one positive change that could make participation in the events less frustrating. The more participants in the events, the easier it is to find those that are competing. The Spring and Fall QSO Parties are always popular events, but even those high participation events yield around 100 entries submitted.

3. Limit the QRP-ARCI sponsored events to one per quarter— The top four contests sponsored by QRP-ARCI when looking at participation each fall in a separate quarter of the year. Starting at the beginning of the year we have the Spring QSO Party in April, the Summer Homebrew Sprint in July, the Fall QSO Party in October and the Holiday Spirits Homebrew Sprint in December. These are always the four contests with the most number of entrants in any given year, and could become the basis for quarterly contesting sponsored by QRP-ARCI. While this would eliminate 8 QRP-ARCI sponsored contests from the calendar, there are plenty of QRP operating opportunities in the variety of other on-air contests. Most contests have a QRP category and it is simply a matter of getting on the air any weekend and you can find a contest or activity that recognizes QRP participation in their results.

Mark Your Calendars for these QRP ARCI Contests:

6 July 2014 — Summer Homebrew Sprint
23 August 2014 — Welcome to QRP
6 & 7 September 2014 — The Two Side Bands Sprint
11 & 12 October 2014 — Fall QSO Party
27 November 2014 — Top Band Sprint
14 December 2014 — Holiday Spirits Homebrew Sprint

Visit www.qrparci.org for more contest information

Please let me know your suggestions on how to improve the contest offerings from QRP-ARCI, as well as how to make it easier for the participants to find each other. We are looking at changing the contest offerings for 2015 to keep the QRP-ARCI sponsored events current, and will take all suggestions under consideration.

Looking back at the past quarter, I must first apologize for not having a column in the past issue of *QQ*. I suffered a major computer failure, and lost a lot of data. Since I had to make an update/upgrade as a result, I changed from PC to MAC. I had been PC since 1987—but am happy with the change.

Grid Square Sprint

Up first this quarter was the Grid Square Sprint. There were a total of nine participants in the sprint, and leading the way was Alan Shafer, AC8AP with 16,464 points who established and maintained a strong lead over second place Barry Ives, AI2T and his total of 6,944 points. Rounding out the top five spots were John Collins, KN1H with 3,290 points, Brian Downs, W3ATT with 3,080 points and Harold Slack, VE5BCS with 2,268 points.

Top 5 Grid Square Sprint	
Alan Shafer, AC8AP	16,464
Barry Ives, AI2T	6,944
John Collins, KN1H	3,290
Brian Downs, W3ATT	3,080
Harold Slack, VE5BCS	2,268

Top 10 Spring QSO Party	
Jorge Daglio, EA2LU	277,046
Jim Lageson, NØUR	271,950
Brian Campbell, VE3MGY	244,664
Robert MacKenzie, VA3RKM	120,050
Don Weiss, KØFX	89,999
Michel Audette, VE2DJN	89,698
John Thompson, K3MD	87,906
Art Davis, N4UC	80,360
Bob Patten, N4BP	75,208
Gary Ekker, KF7WNS	60,228

Spring QSO Party

The big offering of the quarter was of course the Spring QSO Party with over 50 participants. Competition was tough as usual, and a new name emerged on top of the scoresheet. Congratulations to Jorge Daglio, EA2LU who took first place honours home to Spain with 277,046 points. Also topping the 200,000 point plateau were Jim Lageson, NØUR with 271,950 points and Brian Campbell, VE3MGY with 244,664 points who was also the top scoring A1 antenna entrant. Great to see three separate countries represented in the top three scores. We are truly an international organization and it is starting to

2014 GRID SQUARE SPRINT RESULTS

CALL	QTH	BANDS	CLASS	PWR	Qs	PTS	GRIDS	MULTS	SCORE
AC8AP	OH	HB	A1	< 5W		98	24	7	16464
AI2T	NY	HB	A2	< 5W		62	16	7	6944
KN1H	NH	HB	A1	< 5W	10	47	10	7	3290
W3ATT	VA	20	A1	< 5W		40	11	7	3080
VE5BCS	SK	HB	A1	< 5W	9	36	9	7	2268
KE9SA	WI	20	A1	< 5W	7	23	7	7	1127
VA3RKM	ON	20	A1	< 5W	5	22	4	7	616
AB7MP	WA	HB	A1	< 5W	3	15	3	7	315
W2JEK	NJ	20	A1	< 5W	2	10	2	7	140

2014 SPRING QSO PARTY RESULTS

CALL	QTH	BANDS	POWER	#QSOs	PTS	SPC	MULT	SCORE
A1 Antenna Category								
VE3MGY	ON	AB	< 5W	130	514	68	7	244664
VA3RKM	ON	AB	< 5W	77	350	49	7	120050
KF7WNS	OR	HB	< 5W	55	239	36	7	60228
N1ABS	MA	AB	< 5W	61	260	30	7	54600
KØPE	IA	20	< 5W		280	27	7	52920
N3PM	PA	AB	< 250mW	36	162	21	15	51030
K2ZR/4	FL	15	< 5W	55	275	24	7	46200
W7GB	WA	HB	< 5W	40	188	31	7	40796
KD2JC	NJ	AB	< 5W		181	30	7	38010
VE3EUR	ON	AB	< 5W		168	31	7	36456
AB8FJ	OH	20	< 5W	52	230	22	7	35420
W9CC	IN	AB	< 5W	36	168	26	7	30576
NX1K	WI	AB	< 5W	51	189	23	7	30429
KB5JO	TX	HB	< 1W	28	131	22	10	28820
WR4I	VA	AB	< 5W	37	169	24	7	28392
KN1H	NH	AB	< 5W	24	114	21	7	16758
WA5RML	TX	AB	< 5W		132	18	7	16632
WA4ZOF	AL	20	< 5W	24	120	19	7	15960
W2JEK	NJ	AB	< 5W	23	109	18	7	13734
K4YND	VA	20	< 5W	28	113	17	7	13447
WA1GWH	NY	20	< 5W	26	109	16	7	12208
OH2BT	Finland	HB	< 50mW	11	55	11	20	12100
WA9S	IN	20	< 5W	25	107	16	7	11984
KC4ZA	VA	AB	< 5W	26	124	13	7	11284
K4KJP	AL	HB	< 5W		64	25	7	11200
K2ARM	NY	AB	< 5W	20	97	16	7	10864
VE3DQN	ON	AB	< 5W		89	17	7	10591
KBØETU	AL	HB	< 5W	22	104	14	7	10192
W1PID	NH	AB	< 5W	20	96	15	7	10080
WBØCFF	MN	20	< 5W	16	74	15	7	7770
VE5BCS	SK	HB	< 5W		71	13	7	6461
WA8SAN	OH	20	< 5W	14	67	13	7	6097
W5MSQ	TX	HB	< 5W	15	69	11	7	5313
WA4NZD	AL	HB	< 5W	13	65	9	7	4095
KA6AIL	CA	15	< 5W	11	52	9	7	3276
VE7KBN	BC	20	< 5W	10	43	10	7	3010
W2DMZ	FL	AB	< 5W	9	45	7	7	2205
VE3FUJ	ON	AB	< 5W	9	33	8	7	1848
A2 Antenna Category								
EA2LU	Spain	HB	< 5W	109	514	77	7	277046
NØUR	MN	AB	< 5W	134	525	74	7	271950
KØFX	CO	AB	< 5W	68	299	43	7	89999

...continued on next page

2013 FALL QSO PARTY RESULTS (continued)

CALL	QTH	BANDS	POWER	#QSOs	PTS	SPC	MULT	SCORE
VE2DJN	QC	AB	< 5W	74	298	43	7	89698
K3MD	PA	AB	< 5W	72	299	42	7	87906
N4UC	AL	HB	< 5W	61	287	40	7	80360
N4BP	FL	15	< 5W	73	316	34	7	75208
K7SS	WA	HB	< 5W	49	230	37	7	59570
AI2T	NY	AB	< 5W		223	36	7	56196
KIØJ	CO	HB	< 5W		141	27	7	26649
W3TS	PA	AB	< 1W	27	127	20	10	25400
W1FMR	NH	AB	< 5W	32	148	21	7	21756
NA6MG	CA	HB	< 5W	13	62	11	7	4774
SI5Y	Sweden	15	< 5W	15	70	9	7	4410
WB8LZG	MI	20	< 5W	9	42	7	7	2058
WA8HSB	AL	HB	< 5W	8	40	7	7	1960

show in our contest entries. Rounding out the top five spots were Robert MacKenzie, VA3RKM with 120,050 points and Don Weiss, KØFX with 89,999 points. Other notable winners were Curt Hulett, KB5JO the top scoring under one watt entrant with 25,400 points, Mike Zyara, N3PM the top scoring under 250 milliwatt entrant with 51,030 points and Risto Tiilikainen, OH2BT the top scoring under 50 milliwatt entrant with 12,100 points.

Top 5 Hoot Owl Sprint

Robert Wolsh, WB3T	6,295
Jim Gooch, NA3V	2,205
Mike Zyara, N3PM	1,920
John Watkins, NØEVH	1,617
Donald Younger, W2JEK	700

Hoot Owl Sprint

Finally, the Hoot Owl Sprint wraps up the contesting quarter. This one tests the operators abilities to make contacts into the evening, and runs from 8 p.m. to midnight local time. A challenge for sure as not all participants are on the air at the same time, and for those in Europe, the CQ WPX contest is still going strong during the contest time slot. There were seven entrants for this contests, and Robert Wolsh, WB3T made good use out of the portable bonus points to claim top spot with 6,295 points. Second place went to Jim Gooch, NA3V with 2,205 points just keeping ahead of third place finisher Mike Zyara, N3PM and his 1,920 points.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

Spring QSO Party Soapbox

As always very funny contest, good conditions in all three high bands, 9 stations three band QSO, 17 stations two band QSO and some Europeans working the contest. Excellent signal from OH2BT with his 50 mW. Thanks to all who called me, see you in the next contest! **—EA2LU**

Lots of DX all over the bands from 40-10m as propagation was excellent with the SSNe at 120 for the weekend. Didn't work as many regulars as usual. Great to be able to work EA2LU on both 10m and 15m. Thanks for all the QSOs. **—VE3MGY**

Poor participation by QRPers made the time seem long. I was glad some QRO ops paused to give me some "pity-points" after long periods of CQing. **—VA3RKM**

This activity has quite a problem with overlap with the MO, MS, and SP DX Contest. Some QSOs are with participants in these. Hard to find QRPers. **—K3MD**

Just a few hours on Sunday afternoon. **—N4BP**

My first ARCI QSO Party. Lots of activity, lots of fun. I'm looking forward to doing another event. **—KF7WNS**

Conditions were mostly poor, but there were many stations roughing it, and apparently having fun, as I was. **—AI2T**

Lots of fun! **—KØPE**

QRP fun at my Key West QTH "The Southernmost Ham Shack in the Continental USA" **—K2ZR/4**

Not much time to spend on this one. Been a while since I participated also. Thanks to all that worked me. **—KD2JC**

Band conditions OK but participation seemed to be low. **—VE3EUR**

Like many I found the bands to be up and down. This adds to the challenge and the fun. Great bunch of operators as usual. Enjoyed working some old friends and meeting some new ones. **—NX1K**

Prior committments this weekend, so only 4.5 hrs on Sunday afternoon; Thanks to all who participated! **—WA5RML**

Sad but the usable skip from Scandinavia over Atlantic to NA opened only in Sunday at random hours and for very short openings. I heard South Europeans working USA and VE all Saturday and Sunday. I only got 5 transatlantic QSOs with my QRO power of 50 mW. I normally enjoy QRPp fun with 10 mW. **—OH2BT**

Not to many on the band all day. Sure was nice to here Jorge both 5W. **—VE5BCS**

Did not expect to be able to participate due to other committments but they were rained out so I was able to get an hour in. Thanks to all for the QSOs. I enjoyed the laid back style of this QSO Party. **—WA8HSB**

Operators: WA5CM, N5EM, AB5V **—W5MSQ**

Operator: WA2JQZ **—WA4NZD**

Hoot Owl Sprint Soapbox

Yard Portable**—WB3T**

I have been off the air for a couple of years. Good to get the rust out of my system with an hour on the sprint. Unfortunately, N1MM logger changed all the RST reports that I logged to automatic 599s.**—NA3V**

Spent an hour or so on 20, little action on 40. Plenty of QSB to go around**—NØEVH**

Not much activity, but fun anyways.**—VA3RKM**

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